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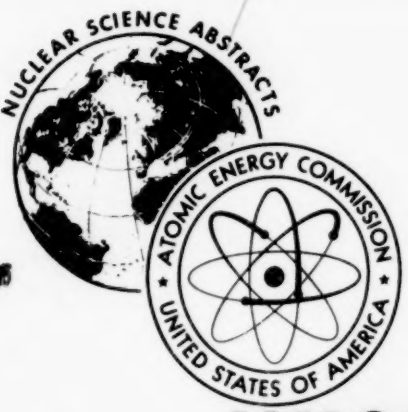

JUL 19 1965

NUCLEAR SCIENCE ABSTRACTS

Volume 19 Number 12

Abstracts 21786–24225

June 30, 1965

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NOTICE

A title page for Volume 19, Numbers 7–12, is included at the back of this issue for use in binding the second quarter of this volume.

CORRECTIONS

NSA Vol. 18, No. 18, pg. 4266. Abstract 31769, the author, Shitsuryo Benseki, should be: Shitsuryo Bunseki.

NSA Vol. 18, No. 22, pg. 5390. Abstract 39918, in line 4 of Descriptive Cataloging... Vestn. Akad. Med. Nauk SSSR... Should read: ... Vestn. Akad. Nauk SSSR...

NSA Vol. 19, No. 1, pg. 197. Abstract 1593, in line two of Descriptive Cataloging... O^{10}... Should read: ... O^{16}...

Volume 19, Number 12, June 30, 1965

NUCLEAR SCIENCE ABSTRACTS

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Volume 19, Number 12 June 30, 1965

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

21786 (ANL-6839) HEALTH DIVISION GAMMA-RAY SPECTROSCOPY GROUP SEMIANNUAL REPORT, JANUARY–JUNE 1964. (Argonne National Lab., Ill.). Jan. 1965. Contract W-31-109-eng-38. 83p. Dep.; $3.00(cy), 2(mn) CFSTI.

Separate abstracts were prepared for the six sections of this report. A list is included of publications during the period covered by this report. (C.H.)

For abstracts of individual sections see: 21813, 21814, 21815, 21816, 22533, and 22685.

21787 (NASA-SP-7011(08)) AEROSPACE MEDICINE AND BIOLOGY. A CONTINUING BIBLIOGRAPHY. (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.). Feb. 1965. 110p. $1.00(CFSTI).

Annotated references are presented to 242 unclassified reports and journal articles in the fields of aerospace medicine and biology. Subject, corporate source, and personal author indexes are included. (C.H.)

21788 (NP-14779) QUARTERLY PROGRESS REPORT NO. 54 [ON RADIOBIOLOGY], JANUARY 15, 1965. (Chicago Univ., Ill. Air Force Radiation Lab.). Contract AF41(609)-2693. 100p.

Separate abstracts were prepared for seven sections of this report. (C.H.)

For abstracts of individual sections see: 21858, 21859, 21860, 21993, 21994, 21995, and 21996.

21789 (NP-14937) ANNUAL REPORT OF THE NATIONAL INSTITUTE OF GENETICS, NO. 14, 1963. (National Inst. of Genetics, Mishima, Japan). 1964. 148p. Dep.(mn).

Separate abstracts were prepared on two sections of this report. Other sections discuss various aspects of the genetics, cytology, and biochemistry of animals and plants. (C.H.)

For abstracts of individual sections see: 21861 and 21862.

21790 (NP-14982) AEROSOL MEDICINE AND BIOLOGY. AN ANNOTATED BIBLIOGRAPHY. VOLUME XI. 1962–1963 LITERATURE. Roman Kenk, ed. (Library of Congress, Washington, D. C. Science and Technology Div.). 1965. 500p. $5.00(CFSTI).

Pertinent references are presented to 2,335 journal articles and other publications during 1962 and 1963 on aerospace medicine and biology. Author and subject indexes are included. (C.H.)

21791 (ORNL-3650) OAK RIDGE NATIONAL LABORATORY [ANNUAL PROGRESS REPORT], 1963. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 251p. Dep.; $6.00(cy), 4(mn)CFSTI.

A summary of research and development during 1963 is presented in sections on reactor development, physical research, biology and medicine, and isotope development. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 21792, 22818, 23163, and 23996.

21792 (ORNL-3650(p.187-219)) BIOLOGY AND MEDICINE. (Oak Ridge National Lab., Tenn.).

Research and development are reported on radiation effects, radiation genetics, properties of biological cells and molecules, terrestrial and fresh-water ecology, radiological physics, health physics, radiation instrumentation, estimation of internal dose, and nuclear energy civil effects. (J.R.D.)

21793 (SC-RR-65-47) PRELIMINARY REPORT ON MICROBIOLOGICAL STUDIES IN A LAMINAR DOWN-FLOW CLEAN ROOM. V. E. Arnold, A. J. Jack, J. G. King, R. C. Marsh, and W. J. Whitfield. Confirmation Study by: John W. Beakley (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract [AT(29-1)-789]. 27p. Dep.; $2.00(cy), 1(mn) CFSTI.

Based on a preliminary investigation (and an independent confirmation study), it appears that the potential of the Sandia laminar down-flow clean room to control airborne microbiological contamination (bacteria and fungi) is approaching the absolute. In the original series of tests, no bacteria or fungi spores were introduced as test organism. Only those organisms were used which were naturally present in the atmosphere and those which were inadvertently introduced by personnel performing the tests. In the confirmation study, tracer bacteria were introduced in one series as additional proof. Based on the results of the experiments it is concluded that filtration and airflow control alone can control airborne bacteria and fungi as successfully as it can airborne dust and droplets. (auth)

21794 (UCLA-12-541) SEMIANNUAL PROGRESS REPORT FOR THE PERIOD ENDING DECEMBER 31, 1964. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Contract AT(04-1)-Gen-12. 121p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Separate abstracts were prepared for six sections of this report. (C.H.)

For abstracts of individual sections see: 21795, 21811, 21819, 21820, 21865, and 22019.

21795 (UCLA-12-541(p.93-9)) BIOPHYSICS. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Design features are described for a blood cell-size analyzer system that employs a Coulter Counter coupled to a multichannel analyzer. A scanner was developed for use in brain tumor scanning using radioisotopes. The mechanism of the indirect action of ionizing radiation was studied in dilute aqueous adenine solutions. The ability of

various ions and simple molecules to protect adenine from radiolysis was measured by spectrophotometric methods. (C.H.)

21796 (JPRS-28782) SCIENTIFIC REPORTS OF THE HIGHER SCHOOLS, BIOLOGICAL SCIENCES. Translated from Nauchn. Dokl. Vysshei Shkoly, Biol. Nauki, No. 3, 26-9; 40-3; 54-61; 68-71; 76-90(1964). 51p. (TT-65-30345). $3.00(CFSTI).

Separate abstracts were prepared on two sections of this report. Other sections report the results from various physiological studies. (C.H.)

For abstracts of individual papers see: 21866 and 21867.

21797 (JPRS-29183) RADIOLYSIS OF A DEXTRAN-DERIVED BLOOD-PLASMA SUBSTITUTE AND EFFECT OF Co^{60} ON MUSCLE ATP AND INORGANIC PHOSPHORUS. Translated from Vesti Akad. Navuk Belarusk. SSR, Ser. Biyal. Navuk, No. 3, 107-18(1964). 19p. (TT-65-30541). $1.00(CFSTI).

Separate abstracts were prepared for two papers in this translation. (C.H.)

For abstracts of individual papers see: 21868 and 22288.

21798 HEMATOLOGIC AND CYTOGENETIC EVIDENCE FOR HEMATOPOIETIC CHIMERISM IN THE MARMOSET, TAMARINUS NIGRICOLLIS. N. Gengozian, J. S. Batson, and P. Eide (Oak Ridge Inst. of Nuclear Studies, Tenn.). Cytogenetics, 3: 384-93(1964).

Peripheral blood smears of 20 male and 20 female tamarins (Tamarinus nigricollis) were examined for the presence of the nuclear drumstick appendage in neutrophils. This chromatin body characteristic of female cells was found in significant numbers of neutrophils from males and in some females was found to be absent or in a lower frequency than expected. The distribution of drumstick-bearing neutrophils among these animals was such that they suggested male-female blood chimerism resulting from prenatal vascular placental anastomoses between fraternal twins of this species. Heterosexual chimerism was confirmed by sex-chromosome analyses of tissues from both male and female animals. The drumstick marker, however, did not provide a reliable quantitative index of chimerism as determined by sex-chromosome analysis. Chimerism was found in blood, bone-marrow, lymph-node, and splenic tissue indicating intermixing of the hematopoietic systems of fraternal twins. A new micromethod utilizing an in vivo diffusion chamber for the procurement of mitotic cells for chromosome spreads was described. (auth)

21799 PRELIMINARY RESULTS OF A STUDY OF CERTAIN PULMONARY PHYSIOLOGICAL NORMS IN ADULT INDIANS. V. M. Raghunath, K. Venkataraman, H. S. R. C. Murthy, and S. Somasundaram (Atomic Energy Establishment, Trombay, India). Health Phys., 11: 287-92(Apr. 1965).

The Health Physics Division of the Atomic Energy Establishment, Trombay, is engaged in a continuing study of the physiological norms of adult Indians in order to evaluate the applicability of the secondary standards of radiation protection recommended by the International Commission on Radiological Protection, ICRP. In a previous paper, data on total body weight and the weights of twelve body organs were presented. In the present paper, the results of a study of pulmonary physiological parameters including alveolar ventilation rate, vital capacity, maximum breathing capacity and breathing reserve of 319 adult male subjects obtained with a 9-litre Collin's respirometer are summarized. The results are compared with those obtained by other investigators, insofar as such data are available. Assuming a mean alveolar ventilation rate of 14.25 l/min, the volume of air breathed by an adult Indian during 16 hr not at work is calculated to be 1.37×10^7 ml, as against a value of 1×10^7 assumed for the ICRP standard man. Further studies are in progress. (auth)

21800 PREPARATION OF RADIOIODINATED SERUM ALBUMIN AND RADIOIODINATED EGG ALBUMIN BY GEL FILTRATION. M. F. Abdel-Wahab (Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo) and S. A. El-kinawy. Intern. J. Appl. Radiation Isotopes, 16: 267-71(Apr. 1965).

A simple method for the preparation of radioiodinated egg albumin and human serum albumin is described. The method is based on iodination of dried freshly prepared protein at pH 9.3 in glycine buffer using ^{131}I in the form of $K^{131}I$. Separation of radioiodinated albumin from interfering inorganic compounds was achieved by means of gel filtration using Sephadex G-25. The separated radioactive protein and the starting material showed identical electrophoretic patterns and uv spectra. Confirmation of the separated undenatured proteins was carried out with the help of autoradiography and radioscanning of the electrophorograms. (auth)

21801 PREPARATION OF TECHNETIUM (Tc^{99m})-LABELED SERUM ALBUMIN (HUMAN). H. S. Stern, I. Zolle, and J. G. McAfee (Johns Hopkins Univ., Baltimore). Intern. J. Appl. Radiation Isotopes, 16: 283-8 (Apr. 1965).

A method is described for the preparation of ^{99}Tc-labeled human serum albumin for use as a tracer in studies of blood circulation and blood pools. Data are included on the parameters of the labeling reaction. (C.H.)

21802 BONE-MARROW TRANSPLANT IN AN IDENTICAL TWIN. Stephen D. Mills, Robert A. Kyle, George A. Hallenbeck, Gertrude L. Pease, and Ian C. Cree (Mayo Clinic, Rochester, Minn.). J. Am. Med. Assoc., 188: 1037-40(June 22, 1964).

A graft of hemopoietic cells from an identical twin was used successfully in the treatment of severe hypoplastic anemia of unknown origin in a 9-year-old child. The identity of the twins was established by the history of a single placenta, identity of five blood groups, and by the survival of skin grafts transferred from the donor to the recipient and recipient to the donor. The technique of the marrow transplant is described. The donor under general anesthesia was subjected to multiple punctures of both the posterior and anterior superior iliac spines and crests. Marrow was aspirated into 20-ml glass siliconized syringes containing 1.5 to 2 ml of Hank's balanced salt solution, 40 mg of heparin per 100 ml, with 10% of the solution as fresh human plasma. The aspirate was filtered and collected in siliconized steel beakers. Portions of marrow were given to the recipient in successive intravenous injections, so that no more than 20 min elapsed between collection and injection of any part of the bone marrow. The 459 ml of fluid removed from the donor contained 10.04 billion cells. No immediate or delayed reaction attributable to the transplantation was noted. Six weeks later, the child was clinically improved and had required no blood transfusion since the marrow transplantation. Similar success in treatment of marrow failure, also in a 9-year-old girl, has been reported. This brings to five the number of reported cases of isogenic bone-marrow transplants, three of them successful. (BBB)

21803 RECOVERY FROM MARROW FAILURE FOLLOWING ISOGENIC MARROW INFUSION. E. Donnall Thomas, John H. Phillips, and Clement A. Finch (Univ. of Washington, Seattle). J. Am. Med. Assoc., 188: 1041-3 (June 22, 1964).

Infusion of isogenic marrow is effective in restoring marrow function after lethal irradiation, and, similarly, isogenic marrow may in some instances prevent death from marrow failure following chemotherapy for malignant disease. This report describes a case of idiopathic bone-marrow failure with recovery following an infusion of isogenic marrow from an identical twin. Four similar cases are reviewed. In a 9-yr-old girl, one of a set of identical twins, epistaxis and hematemesis developed, and in view of evident marrow failure, it was decided to give an infusion of marrow from her twin. Studies of fingerprints, palm and sole prints, and a variety of morphological characteristics indicated the twins to be identical. Marrow was obtained from the normal twin under general anesthesia, about 50

marrow aspirations being performed on the anterior and posterior iliac crests and tibiae. The aspirated marrow was placed immediately in Hank's balanced salt solution containing heparin and passed through stainless-steel screens. The final volume was 300 ml, containing 6.1×10^9 nucleated cells. The marrow suspension was immediately administered intravenously to the patient. Neither the patient nor the donor showed any ill effects from the marrow procurement and administration. Response in platelets and reticulocytes was evident after seven days, and a slower but sustained response in white blood cells was also observed in the recipient twin. Six months later the patient was clinically and hematologically normal. Including this case, five patients with marrow failure are now known to have been treated by an infusion of isogenic marrow obtained from an identical twin. In two instances the marrow infusion was without apparent benefit. In the three patients who have recovered after isogenic marrow infusion, recovery began shortly after marrow infusion. Recovery of three of five patients treated by isogenic marrow infusion suggests successful marrow engraftment, since experience with other cases indicates a much higher mortality in these patients. Infusions of allogeneic marrow in patients with marrow failure have shown little evidence of success. Lack of success is not surprising since these patients presumably have an intact immune system of defense against foreign grafts. (BBB)

21804 EFFECT OF HEAT AND PLATING MEDIUM ON SURVIVAL OF ESCHERICHIA COLI AFTER TREATMENT WITH RADIOMIMETIC CHEMICALS. Antonio Zampieri and Joseph Greenberg (Palo Alto Medical Research Foundation, Calif.). J. Bacteriol., 89: 931-6(Apr. 1965).

Survival of Escherichia coli strain S and its radioresistant mutant R_4 after treatment with mitomycin C, azaserine, nitrogen mustard, 1-methyl-3-nitro-1-nitrosoguanidine, nitrofurazone, and proflavine was studied. With all agents except proflavine, R_4 was more resistant than was S. Survival of strain S was greater on minimal glucose-salts medium than on Penassay (Difco), and greater on the latter than on Tryptone (Difco) agar; survival of S was greater when posttreatment incubation temperature was 45 C than when it was 37 C. Post-treatment plating medium or temperature had no effect on survival of R_4. Visible light did not affect survival of S or R_4. The survival curves of R_4 were exponential; those of S exhibited decreasing sensitivity with time of exposure. With proflavine, photoactivation by visible light was demonstrable, but there was no difference in survival between S and R_4. Survival of either strain was not affected by post-treatment plating medium or incubation temperature. (auth)

21805 PATTERNS OF MARROW HYPERTROPHY AND ATROPHY IN MAN. Donald Van Dyke and Hal O. Anger (Univ. of California, Berkeley). J. Nucl. Med., 6: 109-20 (1965).

From positron camera studies of the gross distribution of erythropoietic marrow in patients with various hematologic diseases, it has become apparent that hypertrophy and atrophy of the marrow tend to follow a characteristic pattern. Both hypertrophy and atrophy frequently begin centrally and extend outward to the periphery of the skeleton. A classification of patterns based on three major stages of hypertrophy and three stages of atrophy is proposed. (auth)

21806 PATHOGENICITY OF ROUS SARCOMA VIRUS FOR MONKEYS. L. A. Zilber, B. A. Lapin, and F. I. Adgighytov (Gamaleya Inst. of Epidemiology and Microbiology, Moscow and Inst. of Experimental Pathology and Therapy, Sakhumi, USSR). Nature, 205: 1123-4(Mar. 13, 1965).

Experiments showed that macacus rhesus, macacus nemestrinus, and Papio hamadryas monkeys are susceptible to Rous sarcoma virus and develop sarcomas within a short time following infection. It is pointed out that monkeys are apparently very similar to man in their susceptibility to cancer. (C.H.)

21807 EVIDENCE FROM MICE CONCERNING THE NATURE OF THE MUTATION PROCESS. W. L. Russell (Oak Ridge National Lab., Tenn.). p.257-64 of "Genetics Today." New York, Pergamon Press, 1964.

This paper has summarized some of the more definitive results from which tentative conclusions and working hypotheses can be reached concerning the nature of the mutation process. Some correction or modification of the conclusions will undoubtedly be necessary as more evidence comes in. It seems certain that current lines of investigation on the mouse can provide the material not only for this modification, but also for a considerable extension of our knowledge of the mutation process. This kind of knowledge has not yet been attained via the molecular level, but there is, of course, a good prospect that the two approaches will meet at some points before long. (auth)

21808 EQUIPMENT AND DOSIMETRIC STUDIES IN THE BIOLOGICAL CHANNEL OF THE IRT-2000 REACTOR. Yu. I. Bregadze, I. V. Breikin, D. Ya. Gubatova, R. Ya. Kemer, and A. A. Lapenas (Inst. of Biological Physics, Moscow; Inst. of Biology, Academy of Sciences, Latvian SSR; and Inst. of Physics, Academy of Sciences, Latvian SSR). p.3-11 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

Descriptions are given of semi-automatic equipment and experiments for the biological channel of the IRT-2000 reactor. The stand for treating biological objects, containers, and filter distributions is discussed. The installation is capable of measuring biological reactions at a wide range of doses. The minimum γ emission was 11% of the total tissue dosage. Fast neutron passage through the channel did not effect their spectra. Prepared sulfur tablets were used as monitors for phantom measurements of objects irradiated with fast neutrons. (R.V.J.)

21809 LE RICERCHE SCIENTIFICHE PROMOSSE DALLA COMMISSIONE DI STUDIO PER LA GENETICA (ORA CENTRO NAZIONALE DI GENETICA) DEL CONSIGLIO NAZIONALE DELLE RICERCHE DALLA SUA ISTITUZIONE (20 LUGLIO 1961) AL 31 DICEMBRE 1963. Consiglio Nazionale delle Ricerche Quaderni de "la Ricerca Scientifica." 25. (The Scientific Research Promoted by the Commission for Study of Genetics (Now National Center of Genetics) of the National Research Council from its Institution (July 20, 1961) to December 31, 1963). Giuseppe Montalenti. Rome, Consiglio Nazionale delle Ricerche, 1964. 224p. L. 2400; $4.80.

The genetic studies on plants, insects, microorganisms, monkeys, other mammals, and man carried out at the Universities of Milan, Padua, Bari, Pisa, Firenze, Pavia, Parma, Turin, Cagliari, Naples, Rome, and Modino and by the Instituto Superiore de Sanita and the Center for the Study of Genetics at Pavia are briefly summarized. The publications made on completed studies are tabulated. (J.S.R.)

21810 MODERN GENETICS. VOLUME 1. J. A. Serra. London, Academic Press, 1965. 548p. 105s.

Recent data on microbial and molecular genetics are integrated into the basic frame of classical genetics to provide a comprehensive basic book for the advanced student or postgraduate research worker. The role of x radiation in chromosome breakage is discussed briefly. (C.H.)

Ecology

Refer also to abstract 21817.

21811 (UCLA-12-541(p.101-30)) ENVIRONMENTAL RADIATION. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Results are summarized from a number of studies conducted during the summer and fall of 1964 on the ecology of plants and animals of the Nevada Test Site. Data are included from environmental studies, an inventory of vascular plants, the radioactivity of kangaroo rats when eating con-

taminated food and living on contaminated sand; the energy requirements of rodents; the effects of exposure to low-level chronic γ radiation on the fertility of deer mice, Peromyscus maniculatus, the effects of γ radiation from a ^{137}Cs source on the rodent population of a small area; the development of methods for age estimation of rodents; the dispersion and dispersal of a population of kangaroo rats; the fertility and population density of black-tailed jack rabbits; studies of soil sample heterogeneity in samples for analysis of fission product cycles in agricultural systems; the evaluation of potential biological hazards arising from small increases in environmental radioactivity; the effects of chronic low level γ exposure on desert plant populations; the combined effects of acute γ radiation and dust on desert plants; the influence of stable Sr and Ca on ^{90}Sr and ^{45}Ca in soils and clay minerals; the decay characteristics of neutron-induced radioactivity in soils; the respiratory rate of bush bean roots grown in aeriated nutrient cultures; and the determination of fallout fission products in biological samples, foods, and soil, with emphasis on the food-chain transfer of ^{131}I. Data are included from a study of the effects of γ radiation on lizard and frog populations of a Puerto Rican rain forest. (C.H.)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstracts 22287, 22533, 22534, 22535, 22553, and 22812.

21812 (AEDC-TDR-63-256) RESEARCH STUDY OF THE BIOMEDICAL ASPECTS OF THE PROPOSED AEROSPACE ENVIRONMENTAL CHAMBER. W. Olewinski, T. Marton, L. Wilder, R. Knipe, N. Belasco, D. Ekberg, and W. Bayles (General Electric Co., Valley Forge, Pa. Missile and Space Div.). Dec. 1963. Contract AF(600)-1012. 223p. (AD-424461). $15.50(CFSTI).

The purpose of the study was to determine biomedical requirements and provide design criteria for a man-machine system configuration for use in the Proposed Aerospace Systems Environmental Chamber. The major portion of the study considers the chamber where man will be introduced as a member of the crew of a test vehicle or, if necessary, to rescue personnel inside the chamber in case of emergency. Emergency chamber repressurization was not considered acceptable for rescue purposes. This portion of the study describes the emergencies and rescue procedures to be used in the chamber. Equipment including manipulators, pressure suits, pressurized capsules and associated life support, equipment, transport equipment, personnel locks, and biomedical equipment were studied for use in the chamber. Recommended system concepts, operational procedures, and manpower requirements are outlined. Repressurization for rescue is considered. (auth)

21813 (ANL-6839(p.7-11)) LONG-TERM EFFECTS OF RADIUM DEPOSITION IN MAN: PROGRESS REPORT. A. J. Finkel, C. E. Miller, and R. J. Hasterlik (Argonne National Lab., Ill.).

Data are summarized from a study of the long-term effects of ^{226}Ra deposition in man. Basic studies consisted of acquiring a medical, family, and occupational history, whole-body measurements of Ra by γ spectroscopy, radiography of the entire skeleton, and blood counts. Repeated studies were made on individuals with a radium burden of over 0.1 μCi. Data are presented on the type of malignancy and source of Ra exposure of 21 cases. (C.H.)

21814 (ANL-6839(p.18-39)) DISTRIBUTION OF RADIUM IN HUMANS. C. E. Miller (Argonne National Lab., Ill.).

Data from whole-body measurements and skeletal x-rays of 280 patients were used for the construction of a preliminary dose-response table for ^{226}Ra deposited in man. Additional measurements were made on 42 patients. The data demonstrate that in some patients portions of the skeleton were being irradiated at rates at least twice the average rate calculated from the whole-body measurements. (C.H.)

21815 (ANL-6839(p.40-62)) RADIUM RETENTION IN MICE. I. AFTER SINGLE INTRAVENOUS INJECTION. C. E. Miller and A. J. Finkel (Argonne National Lab., Ill.).

The retention of intravenously injected ^{226}Ra was studied in mice by means of whole-body γ spectroscopy. Procedures and counting geometry are discussed. Data were analyzed with the aid of a computer and are compared with measurements in man. Data on radium and radon retention are presented. (C.H.)

21816 (ANL-6839(p.63-78)) SOME PROBLEMS OF ACCURATE MEASUREMENT OF POTASSIUM IN MAN. R. K. Hukkoo and C. E. Miller (Argonne National Lab., Ill.).

Problems encountered in accurate measurements of K in humans and animals are discussed. Results are reported from an evaluation of 3 whole-body counting techniques for the measurement of K in man. The K content was measured with 3 different arrangements of NaI crystals, with a 4π liquid counter, and by an isotope dilution method. The various whole-body spectrometry techniques were assessed for accuracy by an analysis of the internal consistency of the results. Results are compared from measurements of the K content in patients whose weights ranged from 104 to 336 lb measured by the 7-segment and tilting chair whole-body techniqies employing a scintillation detector and by the isotope dilution method based on ratio of $^{40}K/^{42}K$ after the intravenous or oral administration of ^{42}K. Results indicate that more accurate measurements of K content in the body can be made by a single-crystal, 7-crystal-position technique along the supine body than with the tilting-chair methods. Results also indicated that in normal subjects ^{42}K does not completely exchange with K in bone. (C.H.)

21817 (BNL-867(p.119-50)) LIFE SCIENCES. (Brookhaven National Lab., Upton, N. Y.).

The activities of the Biology Department were devoted to studies of radiation effects and the use of isotopes in biological research. Research is reported on animal physiology, genetics, cell physiology, biochemistry, and environmental biology. Efforts in medical research were devoted primarily to radiation effects in man. Research is reported on biological effectiveness of fast neutrons, factors of neutron reactions, effects of high-energy particles on mammals, radiation effects on blood, measurements of radionuclides in man, properties of hydroxylysine and collagen, nucleic acids in cells, vitamin and amino acid metabolism in neoplasia, use of glucose and carbohydrates in diabetes and obesity, action of neurohypophyseal peptides on membranes, bioenergetic mechanisms of free radicals, growth, aging, and repair of skeletal structures, physiology of lymphoid cells in the dog, life cycle of granulocytes in man, iron accumulation in a regenerative anemia, physiology of trace metals, relations of sodium and genetics to hypertension, and fallout effects on people exposed in the Marshall Islands. (J.R.D.)

21818 (CEA-R-2609) ETUDE CHEZ LE RAT DES POSSIBILITIES DE DECONTAMINATION INTERNE DU FER RADIOACTIF PAR LA DESFERRIOXAMINE B ET LE D.T.P.A.– Ca(II). (Study in the Rat of the Possibilities of Internal Decontamination of Radioactive Iron Using Desferrioxamine B and DTPA– Ca(II)). Pierre Chiadot (Commissariat à l'Énergie Atomique, Grenoble (France). Centre d'Études Nucléaires). Dec. 1964. 15p. Dep.(mn);

The possibilities of internal decontamination of radioactive iron by deferoxamine-B and diethylenetriaminepentaacetic acid (DTPA– Ca(II)) were investigated in rats. The administration of deferoxamine (DF) during four days showed that only 16.3 per cent of injected ^{59}Fe is found in excretions of rats contaminated by 5 microcuries of $^{59}FeCl_3$ and DTPA– Ca(II) is ineffective. The administration of ^{59}Fe chelated by DF results in the retention of 50 per cent of the radioactive cation after four days. Autoradiographic analysis shows a location of the radioactivity in the tissues which accumulate physiological iron. Thus, a part of the metal injected in DF–^{59}Fe(III) form would be incorporated

in the iron biological cycle. D.F. seems unable to block the intestinal absorption of iron in the normal rat, even when the iron is preliminarily chelated. (auth)

21819 (UCLA-12-541(p.15-24)) BIOCHEMISTRY. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Progress is reported in studies on the γ radiolysis of trans-2-actadecenoic acid; the use of metabolic inhibitors in studies of the energy sources for the contraction of beating heart cells in culture, with emphasis on the role of adenosine triphosphate in contraction; the metabolism of long-chain unsubstituted and α-hydroxy fatty acids by yeast; the synthesis of monounsaturated fatty acids in plants; investigations of the wax esters of fish, with emphasis on the castor-oil fish, Ruvettus pretiosus; and the effects of linolenic acid content on the efficiency of photosynthesis in several species of Chlorella. (C.H.)

21820 (UCLA-12-541(p.25-44)) RADIOBIOLOGY. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Progress is reported in studies on the radiation chemistry of DNA's having different base compositions, with emphasis on the radiosensitivity of Escherichia coli having 5-bromo uracil in their DNA; the effects of bromide ions, nitrous oxide, H, and N on the radiosensitivity of Bacillus subtilis; the use of ^{35}S-cysteine in studies on the radiation chemistry of cysteine; the destruction of thymine dimer in ice formed by ultraviolet radiation by exposure to γ radiation; studies on oscillations in enzymatic reactions; ferric ion metabolism in rat liver mitochondria; the synthesis of ciliary protein by regenerating oral structures of Stentor; the function of pinocytes in Amoeba proteus; tracer studies using ^{65}Zn in investigations of Zn distribution in the proteins of chicken eggs and serum; the production of carbonic anhydrase in rat red cells after x irradiation; the erythropoietic activity of fluid from human cerebellar hemangioblastomas; the characteristics of endogenous erythropoietic inhibitors from blood plasma of mice, rabbits, and sheep; the occurrence of mitochondria-like inclusions in avian oocytes; the morphology of embryonic tapeworms; the distribution of ^{65}Zn in the blood serum of laying hens and in egg yolk. (C.H.)

21821 ALTERATION OF THE RENAL EXCRETION OF STRONTIUM, CALCIUM, AND PHOSPHATE BY PYRIDOXINE, PYRIDOXAL, AND PYRIDOXINIC ACID. A. Schmid (Universitat, Munich). Arzneimittel-Forsch., 15: 28-30(Jan. 1965). (In German)

After 30 days oral administration of nonradioactive Sr to 99 young adult female rats the animals were anesthetized and the urinary excretion of Sr, Ca, and phosphate measured over a period of about 6 hr. Sr and Ca were excreted at the same rate, but the level at which Sr appeared in the urine was slightly higher than the Ca level. The Sr concentration of the bone ash was about 8%, and the blood serum concentration was about 6 mg%. Excretion rate of phosphate was initially slow, but reached a high plateau early in the experimental period. Pyridoxine and pyridoxal hydrochlorides and pyridoxinic acid were administered subcutaneously to the animals at dosages of 4.86, 0.491, and 0.546×10^{-4} mole/100 g body wt, respectively. These treatments increased Sr excretion by a max of 77, 53, and 59%, respectively. After the treatment was given, the greatest effect occurred at from 60 to 90 min with pyridoxinic acid, at 90 to 120 min with pyridoxal, and at 240 to 270 min with pyridoxine. On an equimolar basis, pyridoxal and pyridoxinic acid were about 7 times more effective than pyridoxine to accelerate renal excretion of Sr. These effects were 2 to 3 times as great as they were for Ca excretion, which showed similar effects from the treatments. These results suggested a selective effect on Sr excretion which was probably due to pyridoxinic acid. (BBB)

21822 THE METABOLIC BEHAVIOR OF RADIOCERIUM IN THE LIVER-CELL. E. Hansmann, P. F. Periti, W. Huelsen, and A. Catsch (Kernforschungszentrum, Karlsruhe, Ger.). Atompraxis, 11: 134-40(Mar. 1965). (In German)

The dependence of the intracellular distribution of radiocerium upon time and administration of diethylenetriaminepentaacetic acid was determined. The results make it likely that radiocerium forms so-called robust coordination compounds with cellular ligands. (auth)

21823 CONTRIBUTION TO THE STUDY OF THE MECHANISM OF THE COPPER–MOLYBDENUM INTERACTION IN THE RAT. R. Compere, A. Burny, E. Francois, A. Riga, and S. Vanuytrecht (Institut Agronomique, Gembloux, Belg.). Bull. Inst. Agron. Stat. Rech. Gembloux, 32: 171-89(1964). (In French)

The reciprocal antagonism between the copper and molybdenum in foods was studied, and the dynamics of this biochemical phenomenon was determined in rats using copper tracers. The experimental techniques used to determine the Cu–P balance, the kinetics of the intestinal absorption of ^{64}Cu and its accumulation by the liver, and the Cu–Mo interaction are described in detail. The results showed that Mo in the diet favored the accumulation of Cu in the organism; at this level, a Cu–Mo interaction is shown in the sense of an accumulation of an excess of food copper in the presence of large quantities of Mo. Cupremia is considerably increased by the presence of Mo in the diet; Cu–Mo antagonism was shown in the sense of a reduction of the blood accumulation of Cu. This excess of blood Cu is perhaps part of a non-metabolizable chemical compound. At the level of the liver, an excess of food copper does not necessarily favor significant accumulation but increases transition considerably. Mo can, on the contrary, cause hepatic accumulation of Cu while decreasing the hepatic metabolism. Blockage of the accumulated reserves probably occurs under a little useable form and regression of the exchanges between the liver and the blood. (J.S.R.)

21824 THE DECOMPOSITION OF RADIOACTIVE ACETATE IN SOILS. II. THE DISTRIBUTION OF RADIOACTIVITY IN SOIL ORGANIC FRACTIONS. K. C. Ivarson* and I. L. Stevenson (*Soil Research Inst., Canada Dept. of Agriculture, Ottawa). Can. J. Microbiol., 10: 677-82(Oct. 1964).

Soils incubated with ^{14}C-labeled acetate for 6 to 9 hours showed that 22 to 30% of the acetate was oxidized to CO_2. Fractionation of the soil revealed that the radioactivity of the remaining substrate was widely distributed in various fractions. Greatest activity was noted in the acid hydrolyzable humin fraction (50%) with lesser amounts (5 to 10%) being recovered in the fulvic acid and alcohol extract. Hymatomelanic acid, α-humus, and β-humus contained only traces of activity. Ion-exchange separation of the acid hydrolysate of the humin fraction indicated that a considerable portion of the activity was associated with an unidentified compound which had certain characteristics of itaconic acid. Radioactivity was also found to be present in the 15 amino acids identified. (auth)

21825 INFLUENCE OF THE "DETRITUS" IN THE FIXATION OF RADIOELEMENTS IN MARINE MEDIUM. Roger Chesselet and Claude Lalou (CNRS, Gif-sur-Yvette, France). Compt. Rend., 260: 1225-6(Jan. 25, 1965). (In French)

The role of detritus as an important agent for the concentration of some artificial radioelements present in marine milieu such as ^{141}Ce, ^{144}Ce, ^{144}Pr, ^{103}Ru, ^{106}Ru, ^{106}Rh, ^{95}Zr, and ^{95}Nb is discussed. The detritus, serving in particular for the nourishment of benthic fauna, can play an essential role in the transfer of radioactivity in the food chain. (tr-auth)

21826 BEHAVIOR OF RADIOSILVER ADMINISTERED TO AMPHIBIAN LARVAE. Yutaka Koshida (Nara Medical Univ., Japan). Dobutsugaku Zasshi, 74: 6-10(Jan. 1965). (In Japanese)

The distribution of radiosilver in various tissues and organs in larvae of Rhacophorus arboreus and Hynobius nebulosus reared in tap water containing $^{110m}AgNO_3$ with carrier silver nitrate equivalent to 1.5 μg Ag per ml, was

studied by the aid of photometry and autoradiographs. No essential difference in radiosilver distribution was found between the two species. Radiosilver was found to be retained markedly in intestinal and branchial epithelium, slightly in pigment epithelium of retina, skin, and coelomic epithelium and hardly any in muscle, cartilage, brain, and other tissues. Rhacophorus larvae accumulated radiosilver in the lumen of the intestine as much as a 20 times higher concentration than those of the rearing water, whereas in Hynobius larvae the case is altered. This may be due to the fact that Rhacophorus larvae have opportunities to take up the radiosilver deposited on the wall of the vessel more frequently than Hynobius larvae which never nibble on the wall. Radiosilver injected into tissue such as muscle or brain remained at the site of injection, showing no symptoms of disappearance at least within 48 hours. If radiosilver is used for the purpose of detecting cell migration in the course of regeneration or development, radiosilver may be suitable for labeling muscle or epithelial cells. (NSA of Japan)

21827 RADIOIODINE LABELING OF SERUM ALBUMIN IN VIVO. K. Shimaoka and B. D. Thompson (London Univ.). Ecdocrinology, 76: 570-7(Apr. 1965).

Bovine serum albumin followed by ^{131}I was introduced into the circulation of rats. After 24 hr the serum was examined to see if the exogenous protein had been labeled. Radioiodine-labeled bovine serum albumin was detected in the rat serum by 2 methods: gel filtration on Sephadex G 200 to show the formation of a labeled antigen/antibody complex after reacting the rat serum with rabbit anti-cow serum, and electrophoresis on cellulose acetate to separate labeled bovine serum albumin from rat serum proteins. The results show that in vivo radioiodine labeling of a circulating protein is feasible and suggest that the various albumin-like iodoproteins that have been found in the serum and thyroid of man and experimental animals may all be simply iodinated serum albumin. Evidence supporting this hypothesis and possible sites of serum protein iodination are discussed. (auth)

21828 RETENTION AND EXCRETION OF STRONTIUM-85 IN MICE, RATS, AND RABBITS—EXTRAPOLATION TO LONG-TERM RETENTION IN HUMANS. M. Fujita and J. Iwamoto (Japan Atomic Energy Research Inst., Tokyo). Health Phys., 11: 271-81(Apr. 1965).

The patterns of retention and excretion of ^{85}Sr in mice, rats, and rabbits were studied up to 260 days after a single injection. The results can be fitted with power functions until 100 days, but after that the exponents increase gradually with time. The data on retention in these animals are compared with human results which are known up to 400 days. On the assumption that the patterns of the retention obtained by these small animals are epitomes of that in humans, it is suggested that the long-term retention of Sr in humans will be expressed roughly by $0.80\ t^{-0.30}$ until 6000 days after injection. The ratios of urine to total excretion were also studied in these animals. The values are compared with human results. (auth)

21829 FACTORS INFLUENCING THE ACCUMULATION OF ^{131}I IN COLORADO DEER THYROIDS FOLLOWING 1961-1962 NUCLEAR WEAPONS TESTS. F. W. Whicker, E. E. Remmenga, and A. H. Dahl (Colorado State Univ., Fort Collins). Health Phys., 11: 293-6(Apr. 1965).

Radioiodine concentrations were measured in the thyroids of north-central Colorado mule deer which were collected singly each week and in larger numbers during the hunting seasons from October 1961 through May 1963. The trends in thyroid ^{131}I concentrations were reflective of atmospheric nuclear tests and levels of environmental fallout contamination throughout the study. Variation in thyroid activity between individuals was studied by analysis of thyroids from numerous deer taken on selected days during hunting seasons. The frequency distribution of radioiodine levels was skewed with the greater proportion of the values falling below the mean. An analysis of variance indicated that age had a significant effect upon radioiodine accumulation, with the higher burdens occurring in the younger age groups, but that there was no significant difference between sexes. The analysis also indicated no significant interaction between sex and age. Fetal thyroids contained radioiodine in levels which increased exponentially with age. Near-term fetuses had thyroid radioiodine concentrations up to ten times greater than those of their dams. No activity was found in the thyroids of fetuses in the embryonic stage. (auth)

21830 NATURAL URANIUM AND GRAZING ANIMALS. R. J. Garner (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Health Phys., 11: 323(Apr. 1965).

Results are reviewed from studies on the uptake of natural U by grazing animals. The data are used to estimate the content of U in milk, mutton, and beef. Estimates are presented for the daily intake of U by a child. (C.H.)

21831 TRACE ELEMENTS IN HUMAN TISSUE. PART III. SUBJECTS FROM AFRICA, THE NEAR AND FAR EAST AND EUROPE. I. H. Tipton (Univ. of Tennessee, Knoxville), H. A. Schroeder, H. M. Perry, Jr., and M. J. Cook. Health Phys., 11: 403-51(May 1965). (ORNL-P-439).

Central values and an estimate of variation about the central values are given for twenty-four trace elements and the ash per cent of dry weight of samples of ten different tissues of 162 adult subjects from outside the continental United States. When groups of adult males from different geographical locations were compared, essential elements showed little geographical variation but those elements for which no role is known showed significant geographical difference. Data are tabulated. (auth)

21832 THE EFFECTS OF EXTRAPERIOSTEAL INJECTIONS OF BLOOD COMPONENTS ON PERIOSTEAL CELL PROLIFERATION. Edgar A. Tonna and Eugene P. Cronkite (Brookhaven National Lab., Upton, N. Y.). J. Cell Biol., 23: 79-87(Oct. 1964). (BNL-7641)

Following extraperiosteal injections of saline, serum, or whole blood, the synthesis of DNA in the cells of the osteogenic layer of the femora of mice was stimulated to approximately two-thirds of the level obtained by fracture of the femora. Irrespective of the material injected, the proliferative response of the cells in the periosteum was similar. These studies have shown that neither bone fracture nor direct disruption of the periosteum is necessary to induce periosteal cell proliferation since a single extraperiosteal injection of physiological saline induces DNA synthesis. (auth)

21833 EFFECT OF EPINEPHRINE ON RADIOIODIDE UPTAKE BY THE NORMAL HUMAN THYROID. Marguerite T. Hays (Univ. of California, Los Angeles). J. Clin. Endocrinol. and Metab., 25: 465-8(Apr. 1965).

Subcutaneous epinephrine, 0.01 mg/kg body weight, was given to normal subjects at various times before and after intravenous ^{131}I for 1- and 2-hr uptake measurement. Paired control experiments were performed. Epinephrine did not affect thyroidal uptake when it was given 30 min after radioiodide or when the 2 substances were given simultaneously. When epinephrine was given 30 to 60 min before radioiodide, uptake was stimulated, and at 24 hr uptake had returned to control values. An intravenous infusion of epinephrine (12.8 μg/min) from 30 to 90 min after radioiodide injection caused a significant depression in the rate of thyroidal accumulation of radioactivity during the infusion. The depression of uptake after epinephrine may be due to decreased thyroidal clearance of plasma radioiodide, to a relative decrease in the radioiodide concentration in the plasma being cleared, or to both these factors. The cause for the rebound stimulation of uptake seen 5 hr after epinephrine is unknown. (auth)

21834 A PROCEDURE FOR EXTRACTING CALCIUM-45 FROM TEETH. Joseph A. Watson and William K. Collett (Univ. of Pittsburgh). J. Dental Res., 43: 1253(Nov.-Dec. 1964).

Analysis of teeth for radioactively labeled mineral components generally requires acid digestion and/or ashing at

elevated temperatures, but these procedures sometimes yield a final product for radioanalysis that is nonhomogeneous or contains residual acidity. To circumvent such difficulties, trichloroacetic acid (TCA) was tested as an extractant of ^{45}Ca from rats' teeth. This reagent frees Ca and may be removed by ether extraction to yield a weakly acidic solution free of gross contaminants. To test this method, Long-Evans rats, aged 34 to 63 days, were injected intraperitoneally with a $^{45}CaCl_2$ solution (sp act. 541 mC/g Ca) at a level of 0.25 μC/g of body weight. The animals were sacrificed at 24 hr and their maxillary incisor teeth were treated with 10% TCA solution (1.0 ml per 20 mg tooth weight) for 3 hr at 80°C. This treatment left an insoluble residue in the mineral solution. This solution was extracted with 5 ml volumes of anhydrous ethyl ether until a constant pH level was reached. Measurement of the ^{45}Ca content of the residue and extract indicated that the isotope is selectively retained in the mineral solution during the extraction procedure. Expressed as a percentage of the total ^{45}Ca activity from all fractions, these results gave a mean recovery efficiency of greater than 99% for the animals used in this study. (BBB)

21835 Cs^{137} DISTRIBUTION IN ITS INTRATRACHEAL INTRODUCTION. G. K. Korolev. Med. Radiol., 10: No. 3, 61-6(Mar. 1965). (In Russian)

Under study was ^{137}Cs distribution in the organs of albino rats with the intratracheal introduction of this element. Radiometric investigations demonstrated the isotope to possess good absorption quality. During the first 24 hours up to 90% of the administered amount of ^{137}Cs (0.4 mC/g of the animal's weight) escaped the lungs. The absorption of the element proceeds by an exponential curve. When penetrating inside the body ^{137}Cs is deposited principally in muscles (46% of the amount introduced). In the myocardium the isotope exchange was noted to proceed at a quicker rate. The isotope was also deposited in the skeletal bones, liver, and other organs. Its highest concentration during the first 24 hours was recorded in the kidneys. Ultimately, no further substantial differences in the isotope content per 1.0 gm of viscera could be marked. Morphological examination of the lungs revealed the appearance of massive hemorrhages and the development of degenerative-inflammatory processes. After a lapse of 15 days regeneration processes began to show up, but complete restitution failed to set in even towards the end of observations (60 days after introduction of the isotope). (auth)

21836 Sr^{90} METABOLISM IN RATS KEPT ON A CALCIUM-RICH DIET. [PART] II. COMMUNICATION. L. A. Buldakov and R. A. Erokhin. Med. Radiol., 10: No. 3, 66-72(Mar. 1965). (In Russian)

Experiments staged on rats demonstrated that with chronic enteral introduction of ^{90}Sr for a period of 200 days the multiplicity factor for the isotope accumulation in the skeletal bones of male-rats comprised 6.97–8.83, and in female-rats–3.51. The surplus calcium content in the ration during poisoning and in the subsequent period was attended by a reduced multiplicity factor of accumulation on the one hand, and by a slowed down elimination of the isotope from the skeletal bones on the other. The amount of ^{90}Sr deposited in skeletal bones did not depend upon the quantity of the isotope supplied in the range of 0.1–74 mC per animal. The accumulation of chronically supplied ^{90}Sr in the skeletal bones of female-rats subject to repeated gestation and lactation was 30% higher than in nullipara animals. The ^{90}Sr transmission to the progeny during pregnancy and lactation increased from one gestation and lactation period to another. (auth)

21837 THE TECHNIQUE OF Cs-137 TRACING IN BONE TISSUES. M. M. Golutvina, Yu. M. Nikolaev, G. A. Kuznetsova, and T. A. Kazakova. Med. Radiol., 10: No. 3, 78-80 (Mar. 1965). (In Russian)

A method intended for estimating the ^{137}Cs bone marrow content is described. The procedure is based on concentrating and eliminating the isotope together with its carrier—hexachlortellurite. To measure the magnitude of radioactivity a malophone unit including a window-counter, assembled by following the pattern of anticoincidences, was employed. The ^{137}Cs products eliminated from the human bone marrow were identified with the aid of a gamma spectrometer. (auth)

21838 COMPARATIVE MEASUREMENT TECHNIQUES FOR INVESTIGATION OF THE ENDOPERITONEAL DISTRIBUTION OF RADIOCOLLOIDS. S. Chiarle and G. Buechi (Universita, Turin). Minerva Nucl., 8: 379-81 (Nov.-Dec. 1964). (In Italian)

The distribution throughout the abdominal cavity in experimental animals of three types of radiocolloid was investigated by destructive measurements of the activity. The distribution of one of these colloids was controlled in vivo by means of radioautographic and dosimetric determinations by means of lithium fluoride thermoluminescent microdosimeters. Colloids of ^{198}Au and two preparations of ^{32}P colloids were used. (C.H.)

21839 PREVENTION OF PLUTONIUM DEPOSITION BY DESFERRIOXAMINE-B. V. H. Smith (General Electric Co., Richland, Wash.). Nature, 204: 899-900(Nov. 28, 1964). (HW-SA-3590)

Properties affecting the efficiency of chelating agents for the removal of internally deposited Pu are discussed. Preliminary studies in rats treated with desferrioxamine B (DFAB) 1.5 and 24 hr after the intravenous injection of 2.0 μc ^{239}Pu indicated that this compound reduced bone deposition to about one-half the value obtained with diethylenetriaminepentoacetic acid (DTPA). A partially additive effect was produced when the two agents were given together. (C.H.)

21840 TANTALUM AND NIOBIUM IN ASCIDIANS. N. Kokubu and T. Hidaka (Tokyo Univ. of Agriculture and Tech.). Nature, 205: 1028-9(Mar. 6, 1965).

Contents of Nb and Ta in the ascidian Styela plicata collected at Aburatsubo Bay, Misaki were determined. On average, Styela plicata was found to contain 0.023% (range 0.010-0.041%) Ta and 0.025% (range 0.015-0.030%) Nb (values percent dry material). Because sufficient numbers of animals were not available it could not be determined whether the fluctuations represent some seasonal or developmental variation. However, the results do demonstrate the accumulation of a considerable amount of Ta in the ascidian body. (P.C.H.)

21841 SUPPRESSION OF INTESTINAL ABSORPTION OF RADIOACTIVE STRONTIUM BY NATURALLY OCCURRING NON-ABSORBABLE POLYELECTROLYTES. Deirdre Waldron-Edward, Thyvalikakath M. Paul, and Stanley C. Skoryna (McGill Univ., Montreal). Nature, 205: 1117-18 (Mar. 13, 1965).

The effectiveness of several naturally occurring, nontoxic, and non-absorbable polyelectrolytes was tested in rats for their ability to decrease the absorption of ^{89}Sr by bone. The materials tested included alginic acid, derived from brown algae; carrogeenin, derived from red algae; pectic acid, prepared from fruit pectin; alginic acid prepared from kelp; a sulfonic acid synthetic resin, Rexyn 101 (Na^+); and a mixed carboxylic cation and anion exchange resin, carboresin. Bone uptake of ^{89}Sr was reduced by all the agents except carrageenin, the polyuronic acids and sulfonic acid resin being the most effective. Experiments carried out under identical conditions using ^{45}Ca mixed with the binding agent, showed that blood levels of ^{45}Ca were affected only to a minor degree. In long-term feeding experiments, in which algenates were mixed with the diet, the ^{89}Sr uptake by bone was reduced to 20% of the control value while the supply of nutritionally essential Ca was maintained. (C.H.)

21842 STUDIES ON THE LIVER UPTAKE MEASUREMENTS OF RADIOISOTOPES. I. FUNDAMENTAL STUDY. Teruo Tokuyama (Chiba Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1348-71(Feb. 1964). (In Japanese)

Basic studies were made of the measurement of liver uptake of radioisotopes, using the phantom. The mean

value, obtained from the count rates on the front and back, showed little variation with the size and depth of the liver and gave a correct liver uptake of radioisotope. If the body thickness of the patient was measured and a correction factor introduced, the influence of body thickness was eliminated and the liver uptake calculated was correct. The elimination of the influence of the radioisotopes in the neighboring organs or of the body background was achieved by the use of B-filters of different sizes and shapes. As standard sources, the cuboid shaped one ($5 \times 5 \times 10$ cm^3) and liver phantom (560 cc), the size of which corresponded to that of the liver and which was embedded in the center of the body phantom made of a material equivalent to the human tissue, were used. The use of a collimator with a wide field of vision and a long distance of measurement (distance from crystal to skin: 60 cm) minimized the influence of error from the collimation. The differential counting method was used to eliminate the scattered radiation. (NSA of Japan)

21843 A METHOD OF INTERSTITIAL IRRADIATION USING RADIOACTIVE MICROSPHERES. I. FUNDAMENTAL STUDY ON INTRA-CAPILLARY DEPOSITS OF MICROSPHERES. Hirotake Kakehi and Noboru Arimizu (Chiba Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1372-8(Feb. 1964). (In Japanese)

Basic studies were made on the intra-capillary embolism of minute radioactive particles. The particles used were insoluble inorganic radioactive sediments, namely, $Fe_3(^{32}PO_4)_2$, $Ag^{131}IO_3$, $^{85}SrCO_3$, and ^{198}Au colloid-absorbed carbon particles, produced chemically. In their intravenous administration in rats and rabbits, it was found that nearly all of the particles whose sizes were from 30 to 50 μ, deposited in the pulmonary tissues and remained there nearly unchanged for some periods of time. When the particles were introduced into a gastroduodenal artery of a dog, area scanning of its upper abdomen revealed that they deposited in the stomach corresponding to the region nourished by the artery, and the histological examination showed the embolus of the particles in the capillaries of the stomach. The results were confirmed by clinical study using the $^{85}SrCO_3$ particles. No complications were observed in the patients when the particles were administered in the blood vessels. (NSA of Japan)

21844 STRONTIUM-90 ACCUMULATION BY SOME VEGETABLE CROPS. F. Haghiri (Ohio Agriculture Experimental Station, Wooster). Ohio J. Sci., 64: 371-4 (Sept. 1964).

The objectives of this study were to determine to what extent different vegetable crops differ in ^{90}Sr accumulation when grown on an acid Ohio soil contaminated with ^{90}Sr and to relate the ^{90}Sr content of plant tissue to the concentrations of major and minor elements found in these plant tissues. (Public Health Eng. Abstr. 45: (Jan. 1965))

21845 SOME CRITERIA FOR REMOVAL OF SKELETALLY BOUND RADIOACTIVE STRONTIUM. Irwin Clark, Frank Rivera-Cordero, and Stanton Cohn (Columbia Univ., New York and Brookhaven National Labs., Upton, N. Y.). Proc. Soc. Exptl. Biol. Med., 118: 879-82(Apr. 1965).

The removal of skeletally bound ^{89}Sr in rats is accelerated by diets whose Ca/P ratios are 4 or greater. Also, supplemental magnesium increases the removal of isotope if the dietary Ca/P ratio is 2 or less. Large dietary Ca/P ratios and supplemental magnesium produce hypercalciuria which is essential for increased ^{89}Sr elimination. Increased intake of magnesium ions routinely decreases urinary phosphorus and fecal calcium causing their balance to become more positive. (auth)

21846 PAROTID SALIVA-SERUM RATIOS OF Ca^{47} IN MAN FOLLOWING INTRAVENOUS ADMINISTRATION OF THE ISOTOPE. I. Zipkin and L. V. Aviole (Public Health Service, Bethesda, Md. and Seton Hall Coll. of Medicine and Dentistry, Jersey City, N. J.). Proc. Soc. Exptl. Biol. Med., 118: 898-901(Apr. 1965).

Calcium-47 was administered intravenously to 10 normal adults, and serum and parotid salivas were obtained at intervals during a 24-hour period. The parotid saliva-serum specific ratio was near unity one hour after administration of the isotope to the 5 males. The females appeared to concentrate ^{47}Ca in the parotid saliva particularly during the first 2 hours after intravenous administration of ^{47}Ca. All succeeding ratios were no more than 10% greater than unity. (auth)

21847 EXPERIMENTAL STUDIES ON THE ABSORPTION OF THE RADIOACTIVE ISOTOPE ^{51}Cr THROUGH THE SKIN. A. Czernielewski, D. Brykalski, and D. Depczyk (Medical Academy, Lodz, Poland). Przeglad Dermatol., 50: 411-20(Sept.-Oct. 1963). (In Polish)

These experiments were performed with adult guinea pigs and ^{51}Cr, the half-life of which is 27.8 days, emitting γ rays of energy 0.323 Mev. The isotope was used in the form of Na_2CrO_4, dissolved in 0.9% saline; its specific activity was 10 mC/mg Cr. The animals were shaved and 0.1 ml of the solution was applied to 2×2 cm of skin surface. The animals were kept in metabolic cages and their urine and feces were collected. Subsequently they were sacrificed and the ^{51}Cr content of different organs and excreta was estimated using a NaI(Tl) scintillation counter. Four groups of guinea-pigs were studied: (a) a control group, (b) a group in which the skin had been treated with sodium hydroxide before Cr was applied, (c) a group in which the skin had been treated with a protective cream, (d) a group in which the skin had been sensitized with chromate. The results showed that Cr penetrates through the skin. Compared with controls, in animals pretreated with sodium hydroxide the absorption of ^{51}Cr was greater; on the contrary, the absorption in the sensitized group was smaller. The retention and excretion pattern in the guinea pigs pretreated with a protective cream suggests an alteration of the chromium metabolism in these animals. The ^{51}Cr content observed in excreta and in organs of experimental animals, indicated its absorption through the skin into the organs. The determination of ^{51}Cr in urine could be used as an index of its absorption through the skin. Kidneys were regarded as a critical organ, highly exposed to the action of Cr compounds penetrating the skin. Alkali on the skin considerably increased the absorption of applied Cr even when this did not result in visible lesions. (BBB)

21848 STRONTIUM-90 IN HUMAN BONE, 1962–1963. George W. Gaffney (Baltimore City Hospitals), Robert M. Hallisey, Marshall S. Miller, and Abraham S. Goldin. Radiol. Health Data, 5: No. 12, 620-8(Dec. 1964).

Since late 1961, the Public Health Service's Division of Radiological Health, jointly with pathologists and medical examiners throughout the United States, has conducted a program for analysis of strontium-90 in human bone specimens collected at autopsies. Results obtained in the program through June 1964 are analyzed and detailed results for determinations completed in the interval from November 1963 through June 1964 are included. The data analyzed are for strontium-90 content in bones, mostly vertebrae, for 322 individuals who died in 1962 and 1963 at ages less than 25 years. The frequency distribution for strontium-units (pc Sr-90/g Ca) in bone is log-normal. Justification is given for reporting mean values, as well as standard errors in these, in addition to median values. For age groups 0 to 4, 5 to 9, 10 to 14, 15 to 19 and 20 to 24 years, the mean strontium units found in 1963 deaths were 4.7, 4.2, 3.1, 2.9, and 2.4, respectively. The strontium units for corresponding age groups for 1962 deaths were 3.2, 2.8, 2.3, 2.2, and 1.9, respectively. In the age group 1 to 4 years the mean strontium units were higher than in ages 0 to 12 months (5.0 versus 2.2 for 1963 deaths; 3.5 versus 2.5 for 1962 deaths). The higher values observed in the 1 to 4 year age group, compared with those found in deaths occurring at 0 to 12 months of age, is believed to be influenced predominantly by the discrimination between strontium and calcium by the mother in absorption, excretion, and transplacental passage, although diets frequently lower in strontium units in the first few months after birth may also play

a role. Federal Radiation Council guidance is used to provide some perspective on radiological hazard of strontium-90 burden, even though this guidance does not indicate when protective action should be taken against fallout from nuclear weapons tests. From the bone data there is some suggestion that the skeletal concentration of strontium-90 considered to correspond to the upper limit of Federal Radiation Range 1 for population average was reached in 1963 in the 1 to 4 year group. The upper limit of the skeletal concentration related to FRC Range 1 for individuals was approached in one 1963 case; the value was 13 strontium units. (auth)

21849 TEMPERATURE DEPENDENCE OF CARBON ISOTOPE COMPOSITION IN MARINE PLANKTON AND SEDIMENTS. William M. Sackett (Univ. of Tulsa, Okla.), Walter R. Eckelmann, Michael L. Bender, and Allan W. H. Be. Science, 148: 235-7(Apr. 9, 1965).

Samples of marine plankton collected in high-latitude areas of the South Atlantic where surface water temperatures are near 0°C show a carbon-12 enrichment of 6 per mill relative to samples collected where temperatures are about 25°C. The organic carbon in sediments in the Drake Passage and Argentine Basin also shows a carbon-12 enrichment relative to warmer areas. (auth)

21850 ^{59}Fe LOCALIZATION STUDIES AFTER IONIZING RADIATION EFFECTS (^{60}Co) BY MEANS OF SCINTIGRAPHY AND AUTORADIOGRAPHY. PART 2. AUTORADIOGRAPHIC INVESTIGATIONS. Bruno Chone and Rudolf Wentz (Universitat, Heidelberg). Strahlentherapie, 126: 407-26(Mar. 1965). (In German)

The influence of a single total-body irradiation on iron incorporation in bone marrow, liver, and peripheric blood was investigated in rats, using scintimetric and autoradiographic techniques. A thorough comparison of each method was made. Irradiation doses varied between 100 to 1000 R (^{60}Co-source, Siemens-Gammatron, 2000 Ci). Radio-iron was administered usually 24 to 36 hours after exposure. Radio-iron was administered at later times in some experiment series in order to observe the ^{59}Fe distribution during the late and regeneration stages of acute radiation damage. It may be concluded from the results, that a change in the pathway of ^{59}Fe incorporation in the liver occurs as a result of irradiation. The process seems to be dose dependent. The effect was observed to occur in different stages and is partially reversible. (tr-auth)

21851 SHORT-TERM STUDIES IN RATS WITH ^{47}Ca UNDER THE INFLUENCE OF PREDNISOLONE. D. Glaubitt (Universitat, Mainz). Verhandl. Deut. Ges. Pathol., 47: 413-17(1963). (In German)

Male, Sprague-Dawley rats were injected subcutaneously, over a period of eight to 35 days, with 2.2 mg prednisolone daily. During this time, some of these animals were injected intraperitoneally with 1 to 3 μC ^{47}Ca per 100 g body weight. One to 184 days after injection of the radioisotope the animals were decapitated. Radioactivity measurements and assays of Ca (by a complexiметric method employing ethylenediaminetetraacetate) were made of bone (femur), rib cartilage, kidney, large intestine, liver, spleen, heart, and skeletal muscle. It was found that prednisolone treatment depressed the ^{47}Ca uptake of liver and spleen, but did not appreciably influence that of bone, cartilage, kidney, intestine, heart, or muscle. The sp act. of skeletal muscle fell very rapidly, the biological half life of ^{47}Ca being 1.5 hr in control and 1.3 hr in prednisolone-treated animals. Heart muscle showed the same pattern of ^{47}Ca uptake and release, but the initial uptake was slightly higher than in skeletal muscle. It is concluded that the steroid does not affect Ca metabolism in Ca-rich tissues. (BBB)

21852 LE RICERCHE SCIENTIFICHE EFFETTUATE NEGLI ANNI 1961-1963 E PROGRAMMATE PER GLI ANNI 1964-1967 DALLE IMPRESE E GRUPPI DI RICERCA AFFERENTI AL COMITATO NAZIONALE PER L'AGRICOLTURA DEL CONSIGLIO NAZIONALE DELLE RICERCHE. Consiglio Nazionale delle Ricerche Quaderni de "la Ricerca Scientifica," .23. (The Scientific Studies Made in the Years 1961-1963 and Programmed for the Years 1964-1967 by Organizations and Research Groups for the National Committee for Agriculture of the National Research Groups for the National Committee for Agriculture of the National Research Council). Carlo Arnaudi. Rome, Consiglio Nazionale delle Ricerche, 1964. 216p. L. 2400; $4.80.

Results are summarized from studies made from 1961 to 63 on the application of radiobiology to agricultural and food problems. Data are presented from studies on plant viruses, mountain vegetation, studies on milk, genetic improvement of herbaceous and cultivated plants, forage plants, fruit trees, olive propagation, and ruminants. Publications of complete research are tabulated. The programs proposed for 1964 to 67 are outlined. (J.S.R.)

Radiation Effects

Refer also to abstracts 21817 and 22466.

21853 (ABCC-OO-62) BIBLIOGRAPHY OF PUBLISHED PAPERS OF THE ATOMIC BOMB CASUALTY COMMISSION. (Atomic Bomb Casualty Commission, Hiroshima (Japan)). 1962. Contract [AT(49-1)-Gen-72]. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A list is presented of 75 papers published during 1962 reporting results of investigations by the Atomic Bomb Casualty Commission. The papers discuss radiation effects of the atomic explosions at Hiroshima and Nagasaki and present results of epidemiological studies on the populations of these cities. (C.H.)

21854 (AED-C-04-16) RADIATION EFFECTS ON LIVING TISSUES AND ORGANISMS. Series C: Bibliographies. W. Stahlhofen, comp. (Max-Planck-Institut fur Biophysik, Frankfurt am Main (West Germany)). Oct. 1964. 178p. Dep.(mn).

A list is presented of 439 references to publications since 1960 on the effects of radiation in living tissues and organisms. Report number and author indexes are included. (C.H.)

21855 (BNL-8892) RESEARCH USES OF THE GAMMA FIELD AND RELATED RADIATION FACILITIES AT BROOKHAVEN NATIONAL LABORATORY. Arnold H. Sparrow (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT-30-2-GEN-16. 58p. (CONF-800-3). Dep. (mn); $3.00(cy), 2(mn) CFSTI.

From 6th Japan Conference on Radioisotopes, Tokyo, Nov. 1964.

The gamma sources currently in use at Brookhaven for genetical, botanical and ecological studies are listed and described briefly. They include a 60 c ^{60}Co hot cell source, a 15 c ^{60}Co greenhouse source, a 3160 c ^{60}Co field source, a 9500 c ^{137}Cs forest source, and a 400 c ^{137}Cs pit source. The latter is set up to simulate fallout decay, i.e., exposure rates can be decreased as desired by means of programmed changes in shielding. Described or listed are some of the more important recent experiments, observations, and conclusions covering many areas of investigation in which use has been made of the various radiation facilities listed above. These include studies in radiation cytology and genetics elucidating certain aspects of the dose-rate effects problem; studies on somatic mutations in many species and a list of useful mutations is included; studies of morphological and histological changes induced by irradiation; studies on differences in radiosensitivity among numerous plant species with reference to the significance of nuclear volume and chromosome size as effecting radiosensitivity and a derived method of predicting radiosensitivity including predicted responses given for 33 species of higher plants; studies on the diploid vs. polyploid radiosensitivity problem as related to the so-called protective effect of polyploidy; studies on the relationship between radiosensitivity and the estimated DNA content per chromosome; and studies on the responses of plant species in an old field community and ecology forest subjected to chronic irradiation. Where

results or experiments are not fully described, adequate lists of references are given which cover those aspects mentioned. (67 references) (auth)

21856 (COO-878-15) RECOVERY FROM RADIATION-INDUCED DIVISION BLOCK IN PROTISTS. Final Scientific Report. H. S. Ducoff (Illinois Univ., Urbana). Mar. 1965. Contract AT(11-1)-878. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Data are summarized from studies on mechanisms involved in the recovery of microorganisms from the division-suppressing effects of sub-lethal doses of ultraviolet and x radiation. Results are reported from studies in the algae Brachiomonas submarina, Chilomonas paramecium, and Tetrahymena pyriformis on radiosensitivity of cytocidal and division-suppressing effects, effects of N, photoreactivation, and effects of radioinduced damage to DNA. Results are included from tracer studies on the effects of bromouracil, iodouracil, thymine, amethopterin, and thymidine and metabolic inhibitors on division-suppression after irradiation. (C.H.)

21857 (IA-1010) SUSCEPTIBILITY OF CALLOSOBRUCHUS MACULATUS TO HIGH-DOSE-RATE GAMMA IRRADIATION. A Preliminary Study. A. Neharin, M. Calderon, and O. Yacobi (Israel Atomic Energy Commission, Yavne, Soreq Nuclear Research Establishment). Dec. 1964. 11p. Dep.(mn).

The Caleoptera, Callosobruchus maculatus is an insect pest that causes heavy damage in stored grain. Callosobruchus maculatus in various stages of development was irradiated at high dose rates with a ^{60}Co gamma source. High radiosensitivity was found, the most sensitive stage being the eggs, where 50% and 100% mortality were produced by 1000 and 3000 rads respectively. A mixed population of adults of both sexes was completely sterilized by a dose of 10,000 rads. Eggs were laid but they were not viable. The high radiosensitivity observed is attributed to the high dose rates used. (auth)

21858 (NP-14779(p.1-14)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. I. STUDIES ON THE EFFECT OF X-IRRADIATION ON COENZYME A LEVELS OF THE LIVERS OF MICE. Kei-Ming Yam and Kenneth P. DuBois (Chicago Univ., Ill. Air Force Radiation Lab.).

The concentration of CoA in the livers of normal and irradiated mice was determined by adding extracts of liver to an in vitro acetylation system in which CoA was the rate limiting component of the system. The reaction time and concentration of various components were studied to ensure that the method was a valid assay for CoA. The concentration of CoA in the livers of mice after 700 R of x ray showed no significant change from normal immediately after x ray. A 20% decrease was observed 6 hours after x ray and the concentration then increased by 70% at 2 days after exposure. A decrease was then observed at eight days (35%) after irradiation and the level returned to normal by the tenth day after x ray. These transient changes in CoA concentration, together with previous evidence that x ray does not affect the functional activity of CoA in vivo, indicate that radiation does not exert any important action on CoA. (auth)

21859 (NP-14779(p.15-28)) THE EFFECT OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. II. INFLUENCE OF X-IRRADIATION ON THE DEVELOPMENT OF A DETOXIFICATION SYSTEM FOR PHOSPHOROTHIOATES IN THE LIVERS OF RATS. Florence Kinoshita and Kenneth P. DuBois (Chicago Univ., Ill. Air Force Radiation Lab.).

The effects of 400 R and 600 R of x irradiation on the development of the detoxification system for the phosphorothioate, o-ethyl o-(nitrophenyl) phenylphosphorothioate (EPN) were measured by exposure of weanling male rats to radiation at the age of 22 or 23 days and performing assays on the livers at intervals up to 50 days of age. Development of the enzyme system was delayed by both of these doses of radiation. The development of the hydrolytic phase of phosphorothioate detoxification was also inhibited by exposure of weanling rats to x irradiation thus indicating that the inhibitory effect of radiation on enzyme synthesis extends beyond the area of oxidative microsomal enzymes. Daily administration of phenobarbital and nikethamide resulted in induction of synthesis of the detoxification system for EPN. Maximal induction occurred with 3 to 5 days of treatment and the activity returned toward normal in several days after discontinuing the treatment. Exposure of weanling rats to 21.2 R or 50 R per day over a 10-hour period resulted in no inhibition of the synthesis of the detoxification system for EPN even though some animals received large doses of radiation. (auth)

21860 (NP-14779(p.89-98)) THE INFLUENCE OF LOW LEVELS OF GAMMA AND FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF ANIMALS. I. APPLICATION OF RADIATION-INDUCED CHANGES IN ADENOSINE TRIPHOSPHATASE ACTIVITY OF HEMATOPOIETIC TISSUES TO A STUDY OF CHRONIC GAMMA IRRADIATION AND THE INFLUENCE OF VARIOUS FACTORS ON ACUTE RADIATION INJURY. Robert Tardiff and Kenneth P. DuBois (Chicago Univ., Ill. Air Force Radiation Lab.).

Weanling and adult male rats were exposed to chronic gamma irradiation at dose rates of 21.2 R, 45.0 R, and 51.0 R per day given over a period of 10 hours per day for extended periods of time. Adenosine triphosphatase measurements were made on the spleen and thymus glands of the chronically irradiated animals after various periods of exposure. The increases in adenosine triphosphatase activity of spleen ranged from 133% to 156% of normal depending upon the total dose of irradiation. There was some indication that animals started on the exposures at 23 days of age showed somewhat greater increases in enzyme activity than adults. Chronic gamma irradiation did not appreciably affect the enzyme activity of the thymus glands except in one group which received 3645 R at the rate of 45 R per day. The influence of chronic gamma radiation on the development of a phosphorothioate detoxifying system in the liver was studied and it was found that the system developed to the normal level at least by 45 days of age. A comparison was made on the adenosine triphosphatase activity of the spleens and thymus glands of male rats castrated 30 minutes after irradiation and irradiated controls by performing the enzyme assays at 3 days after exposure to x ray. There was no significant difference in enzyme activity in the two groups of animals indicating that castration did not influence the amount of injury to these tissues. If a beneficial effect from castration occurs in rats, it must involve acceleration of recovery at a period later than 3 days after exposure to radiation. (auth)

21861 (NP-14937(p.116-25)) RADIATION GENETICS IN PLANTS. (National Inst. of Genetics, Mishima, Japan).

Results are reported from studies on radioinduced mutations of rice; the relation of radiation effects to dose rate of γ radiation diploid wheat (Triticum monococcum flavescens) and rice (Oryza sativa); the effects of acute and chronic exposure to γ radiation on growing wheat; the dose rate dependence of mutation rates of γ-irradiated pollen grains in maize; the relation between polyploidy and effects of γ and neutron radiation in wheat (Triticum monococcum, T. durum, and T. vulgare); the relative biological effects of neutrons and γ radiation in seeds of Arabidopsis; and the effects of γ-irradiated pollen grains on mitosis in pollen tubes of Lilium auratum, Impatiens balsamina, Camellia japonica, and Camellia sazanqua. (C.H.)

21862 (NP-14937(p.93-116)) RADIATION GENETICS IN ANIMALS. (National Inst. of Genetics, Mishima, Japan).

Results are reported from studies on radioinduced mutations in Drosophila melanogaster and silkworms. (C.H.)

21863 (NP-14957) EXTRACTIVES AND FUNCTIONAL PERFORMANCE OF FLEXIBLE PACKAGING MATERIALS FOR USE IN RADIATION STERILIZATION OF PREPACKAGED FOODS. G. O. Payne, Jr., and C. H. Spiegl (Continental Can Co., Inc., Chicago, Ill. Central Research and Engineering Div.). Dec. 1964. Contract DA19-129-AMC-162(N). 185p. (FD-3)

Gamma radiation from a Cobalt-60 source caused no

significant change in extractability of six classes of polymeric materials irradiated at food sterilization doses in the presence of food-simulating solvents. Functional performance of flexible laminate pouches as extractive test cells indicated that the food-contacting materials preferred for radiation food pack tests were polyester, polyamide, and polyolefin. (auth)

21864 (TID-21679) THE MOLECULAR AND BIOLOGICAL EFFECTS OF RADIOACTIVE PHOSPHORUS AND X RADIATION ON BACTERIOPHAGE NUCLEIC ACID. Progress Report, March 1, 1964–February 28, 1965. J. G. Van Dyke (New York Univ., N. Y. Dept. of Radiology). Contract AT(30-1)-3220. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Results of investigations indicate that the free phage irradiated with ^{60}Co in a concentrated broth is inactivated by a multiple hit mechanism. A likely hit number is two for phages T2, T4, and T5. The final slopes of the survival curves of T2, T4, and T5 are almost the same. The hit numbers for phages Tl and T7 are less certain and experiments are necessary using a host cell lacking the repair system, i.e., Escherichia coli strain B_{s-1}. Such experiments are now underway. The DNA extracted from gamma-irradiated phage T5 is broken as determined by zone centrifugation, viscosity, and sedimentation in the ultracentrifuge. The number of scissions of the phage DNA is less than the number of hits contributing to lethality. Irradiated phage T5 is able to transfer only part of its DNA to the host cell, although its ability to adsorb is not measurably affected. The measure of transfer was the amount of radioactive P from labeled phage remaining with the cell after blendoring. The results imply that the phage DNA is broken and transfer is allowed only up to the first break. The number of breaks computed on this model was less than the number of hits contributing to lethality. It is possible to infect the host cell with only 10% of the DNA of phage T5 by infecting at high bacterial concentration and then blendoring the complexes. This first 10% of the phage is thought to cause the death of the cell and degradation of the host's DNA. The latter may also be the sole cause of cell death. It was found that irradiation (^{60}Co gamma and soft x radiation) of the phage inactivated its ability to kill the cell and degrade the host DNA. The ability to kill the cell was inactivated to a considerable extent at doses which had comparatively little effect on the transfer of the first 10%. This observation is evidence that cell killing is actually due to a function of the phage DNA and not merely due to the introduction of foreign DNA or attachment of the phage to the cell. (auth)

21865 (UCLA-12-541(p.45-50)) PHARMACOLOGY AND TOXICOLOGY. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Quinoxaline-di-N-oxide was shown to have a radioprotective effect in mice and a radiosensitizing effect in dogs. Possible mechanisms involved are discussed. Results are summarized from studies of the pharmacological and toxic effects of europium chloride in several biological systems. Self-stimulating electrodes were developed and used in studies on the effects of various drugs on the brain of rats. Preliminary results are included from studies of histological changes induced by β particles from Au-plated ^{90}Sr beads implanted in rat femur. (C.H.)

21866 (JPRS-28782(p.36-41)) RESISTANCE OF TRITON LENS TO RADIATION AND TRAUMA. V. V. Popov and V. A. Golichenkov. Translated from Nauchn. Dokl. Vysshei Shkoly, Biol. Nauki, No. 3 82-6(1964).

The heads and eyes of adult salamanders, Triturus vulgaris, were exposed to doses of x radiation ranging from 2,000 to 16,000 R. Two to 3 days later, a fine prick was made into the anterior pole of one of the lenses. These operations were also performed on nonirradiated control animals. The eyes of the experimental and control animals were examined regularly for signs of the development of radiation cataracts and careful studies were also made of histological sections of eyes. No evidence of radiation or traumatic cataract was seen in any animal. It was concluded that this unusual resistance of the lens to radiation injury is due to the close link of its structural physical-chemical and histological components. Results are compared with studies of radioinduced cataracts in frog lens. (C.H.)

21867 (JPRS-28782(p.42-6)) INVESTIGATION OF ELECTRICAL CONDUCTIVITY OF SPLEEN TISSUE OF IRRADIATED ANIMALS. E. (Ye.) V. Burlakova and M. L. Kakushkina. Translated from Nauchn. Dokl. Vysshei Shkoly, Biol. Nauki, No. 3, 87-90(1964).

Results are reported from measurements of the electrical conductivity of spleen tissues from normal rats and rats exposed to 1,000 R γ radiation. Measurements of electrical resistance of the spleen were made immediately after extraction from the cadaver and after the spleen was kept for 3 or 4 hr in a moist chamber. Results showed that the polarization coefficients of spleen tissue of irradiated rats are considerably below those of control rats. It was concluded that the results indicate a disturbance in the physical and chemical structure of the spleen tissue of irradiated rats. (C.H.)

21868 (JPRS-29183(p.10-16)) ACTION OF RADIOACTIVE COBALT (Co^{60}) ON THE CONTENT OF ADENOSINE-TRIPHOSPHORIC ACID AND ACID-SOLUBLE INORGANIC PHOSPHORUS IN THE CARDIAC AND SKELETAL MUSCLES OF RATS. N. M. Labanova. Translated from Vestsi Akad. Navuk Belarusk. SSR, Ser. Biyal. Navuk, No. 3, 114-18 (1964).

Changes in the content of adenosinetriphosphoric acid (ATP) and of acid-soluble inorganic P in cardiac and skeletal muscles of rats exposed to 700 R ^{60}Co γ radiation were followed for 120 days. The myocardinal content of ATP was elevated at all periods after irradiation and the content in skeletal muscle was elevated during the first post-irradiation days and was depressed thereafter. The content of acid-soluble P was increased in the myocardium and decreased in skeletal muscles. The changes in ATP and inorganic P induced by irradiation did not return to normal 120 days after exposure. (C.H.)

21869 THE EFFECT OF IONIZING RADIATION ON THE ACTIVITY OF ADENOSINE TRIPHOSPHATASE IN MITOCHONDRIA OF RAT LIVER, SPLEEN AND HEART. A. M. Dancewicz, Teresa Malinowska, and Dobroslawa Rzepniewska (Inst. of Nuclear Research, Warsaw). Acta Biochim. Polon., 12: 85-94(1965).

Adenosine triphosphatase (ATPase) activity of rat liver, spleen, and heart mitochondria irradiated in vitro with a dose of 10,000 to 40,000 Rads did not differ from control values. ATPase activity in organs of rats irradiated in vivo with 750 R of x rays, tested 30 min, 24 hr, and 48 hr after exposure, showed differences dependent on the pH of the incubation system. (auth)

21870 THE EFFECT OF X RAYS ON FIRST DEVELOPMENTAL STAGES OF MAIZE. K. Erdelsky (Comenius Univ., Bratislava). Acta Fac. Rerum Nat. Univ. Comenianae, Botan., 7: 621-716(1964). (In Czech.)

Maize seeds were irradiated with 60-kv x rays at a dose rate of 450 R/min to total doses of 100 to 20,000 R. Beginning with doses of about 2000 R, inhibition of coleoptile and root growth was seen and with doses of 5000 R and higher a lethal effect was observed. With high radiation doses also changes in shape of the germinating seeds were observed. From irradiated seeds thicker organs grew, with tumors and weak natural pigmentation. With doses of about 2000 R a coil-like growth of some of the coleoptiles was observed. Paper chromatography revealed that in the coleoptiles, roots, and seeds of corn the following amino acids are present: aspartic acid, glutamic acid, serine, glycine, asparagine, glutamine, threonine, valine, leucine, proline, γ-aminobutyric acid, lysine, tyrosine, and histidine. Radiation had an effect on the qualitative composition of amino acids only in one instance: cystine appeared after irradiation. This may be related to the protective effect of SH substances and with the cleavage of proteins by irradiation. In the organs of irradiated corn a signiftcant decrease of the content of some amino acids as well as a pronounced increase in the content of other amino acids was observed,

these changes being proportionate to the doses of radiation. γ-Aminobutyric acid was shown to be especially sensitive, as the content of this substance sharply decreased after irradiation. With the amides (asparagine and glutamine), their accumulation may take place as a result of their protective effect against ammonia, which could be formed from denaturated proteins. The observed accumulation or decrease of the content of certain amino acids depends from the dose of radiation, the organ studied, and the lapse of time from irradiation to assay. Some amino acids reacted specifically to radiation. In coleoptiles of germinating corn, sucrose, glucose, and fructose were found. In the roots sucrose was either not present or present only in traces. In the seeds, rafinose, maltose, sucrose, glucose, and fructose were found. Two and four unidentified saccharides were detected in the seeds on the third and fifth day of cultivation, respectively. At doses up to and including 1500 R, where no changes in growth were detected, no changes of the content of reducing substances and of the various sugars were observed. At higher doses of radiation, the greatest changes were observed in the content of reducing substances and free saccharides of the coleoptiles. In the roots, the changes were much smaller and in the seeds the changes were usually insignificant. A direct dependence of the decrease of reducing substances on the dose of radiation, and an increase of reducing substances as assayed after hydrolysis with oxalic acid, was observed. The decrease of the content of reducing substances corresponds to the decrease of the content of glucose and fructose as assayed by chromatography. The increase of reducing substances after hydrolysis was caused by an unidentified reducing substance; sucrose proved to be exceptionally sensitive to radiation. After lower doses of radiation the level of sucrose in the coleoptiles decreased and after higher doses sucrose was absent. Assays of irradiated corn showed that indoleacetic acid is not very sensitive to x rays, but the biosynthesis of this compound is profoundly influenced by radiation. This was shown by the accumulation of substances of a growth-promoting character after irradiation, i.e., substances which are precursors of indoleacetic acid. Irradiation caused a destruction of naturally growth-promoting and -inhibiting substances, and other growth-promoting and -inhibiting substances emerged. Under the effect of radiation the emergence of specific growth-inhibiting substances was particularly noted. The bibliography cites 223 references. (BBB)

21871 THE RADIOSENSITIVITY OF ESCHERICHIA COLI CULTURES. I. PHYSIOLOGICAL FACTORS THAT INFLUENCE RADIOSENSITIVITY. F. Hernadi, Gy. Csoban, and Zs. Nagy (Medical Univ., Debrecen, Hungary). Acta Microbiol. Acad. Sci. Hung., 11: 99-103(1964). (In German)

Effects of x-ray dose level were studied in E. coli cultures incubated for 14 hr at 37°C. The cultures were exposed to 180-kv x ray at a rate of 800 R/min. To study radiosensitivity of the cultures, percentage survival was measured as a function of the x-ray dose, which was varied from 800 to 6000 R. The survival curve obtained indicated that about 10% of the cells were resistant to the max radiation dose. Alterations in radiosensitivity of the cells were studied as a function of incubation time, using a constant dose of 1600 R. The radiosensitivity of the cultures was greatest at the beginning of the log phase of growth, decreasing to a min at the end of the growth phase. Radiosensitivity increased during the stationary growth phase. It was not possible to establish whether the differences in radiosensitivity observed were related to the cell increase or to the age of the cells. Variations in radiosensitivity may have been related to alterations in physiological state of the culture. The electrode potential curve, which can be used to demonstrate cell viability, was somewhat parallel to the radiosensitivity curve. The authors suggest that this curve may indicate enzymatic activities of the culture. (BBB)

21872 TOTAL HAEMOGLOBIN AND BLOOD VOLUME OF RATS AFTER SUBLETHAL WHOLE-BODY IRRADIATION. Bernhard Tribukait (Karolinska Institutet, Stockholm). Acta Radiol., Therapy, Phys., Biol. (N.S.), 3: 1-11 (Feb. 1965). (In German)

Exposure of rats to 410 R roentgen rays resulted in a continuous decrease in the total hemoglobin and erythrocyte volumes. On the 11th day the values were 75% of the normal. After 6 weeks, however, normal values were again attained. The blood volume remained constant. Cell division was completely blocked between the 1st and 4th days, but started again at day 6, and was doubled at the stage when the total hemoglobin reached a normal level. The daily loss by hemoglobin was twice or 3 times the normal during the first two weeks. Physiologically old and young erythrocytes were decomposed at the same rate. (auth)

21873 STATISTICAL OBSERVATIONS OF LENTICULAR CHANGES IN SURVIVORS OF THE HIROSHIMA A-BOMB: CLINICAL AND STATISTICAL OBSERVATIONS OF DELAYED EFFECTS. George J. Inada and Carl W. Hall (Atomic Bomb Casualty Commission, Hiroshima). Am. J. Ophthalmol., 59: 216-21(Feb. 1965). (TID-21464)

Results are reported from ophthalmologic observations carried out on residents of Nagasaki and Hiroshima exposed to radiation from an atomic explosion. Very significant statistical test results indicate that lenticular opacities observed have definite relationship to ionizing radiation exposure distance from the hypocenter (exposure distance in this instance is used as a relative index of radiation dosage received). Exposure to ionizing radiation does increase the incidence of lenticular changes indicative of ionizing radiation (definite opacities, polychrome posterior capsular roughening, excessive cortical opacities unexplained and, especially, the polychrome posterior capsular plaques). No appreciable differences in opacities by sex or loss of visual acuity were observed. (C.H.)

21874 HEMATOLOGIC RESPONSES TO HUMAN WHOLE-BODY IRRADIATION. ANALYTIC APPROACHES TO BIOLOGIC DOSIMETRY. S. James Adelstein and James B. Dealy, Jr. (Peter Bent Brigham Hospital, Boston). Am. J. Roentgenol., Radium Therapy Nucl. Med., 93: 927-34 (Apr. 1965).

Hematologic data are presented for 6 patients who received total-body irradiation in preparation for kidney transplantation. Three patients (titled the "index group") received an identical dose schedule of 250 R, a 7 day interval, and then 200 R. Their average responses are compared with those observed in other patients exposed to lower doses; the degree of maximal response exhibited some correlation with total dose over the relatively narrow range of 250 to 450 R. For the index group, the exponential disappearance of lymphocytes, reticulocytes, granulocytes, and platelets progressed in that order, with half reduction times in days of 4, 6, 10, and 16, respectively. The exponential disappearance rate of granulocytes in the index group was compared with another study and certain similar features are discussed in terms of marrow inhibition. The early estimate of radiation damage permitted by the use of disappearance rates is an attractive feature and could be employed as an aid in planning optimum treatment for accidentally exposed persons. Moreover, the early peripheral counts are less likely to be influenced by the infection and hemorrhage that may develop with progressive hematologic failure. (auth)

21875 ENZYMATIC DEGRADATION OF PROTEINS EXPOSED TO IONIZING RADIATION. PART I. P.-E. Navellier and Janine Subitte (Laboratoire Municipal, Paris). Ann. Nutr. Aliment., 15: 33-44(1961). (In French)

The in vitro degradation of irradiated proteins by non-irradiated proteolytic enzymes was investigated on casein, fibrin, and ovalbumin. The experimental techniques are described. The proteins irradiated at 0.5, 1, 2, and 5 MRad did not differenciate appreciably from the non-irradiated controls with respect to the proteolytic enzymes papain, pepsin, and trypsin. (J.S.R.)

21876 ENZYMATIC DEGRADATION OF PROTEINS EXPOSED TO IONIZING RADIATION. II. IRRADIATION

IN AQUEOUS MEDIA. P. Navellier and J. Subitte (Laboratoire Municipal, Paris). Ann. Nutr. Aliment., 17: 475-85 (1963). (In French)

The proteins casein, fibrin, and ovalbumin were diluted in a large volume of water before exposure to γ radiation of 0.5 to 5 MRad. The action of the non-irradiated enzymes papain, pepsin, and trypsin on the proteins was determined. The results showed that the sensitivity to proteolysis of the proteins irradiated in aqueous solution did not differ sharply from that of proteins irradiated in powder form. (J.S.R.)

21877 METABOLIC ALTERATIONS AFTER TOTAL-BODY DOSES OF X-IRRADIATION. THE EFFECTS OF X-IRRADIATION ON RAPIDLY LABELED RNA. T. Uchiyama, N. Fausto, and J. L. Van Lancker (Univ. of Wisconsin, Madison). Arch. Biochem. Biophys., 110: 191-4(Apr. 1965).

The rapidly labeled RNA fraction was extracted from 24-hour regenerating livers of partially hepatectomized rats. The profiles of optical density and radioactivity of the RNA obtained from nonirradiated animals were compared with those obtained from animals receiving 600, 1000, and 1500 roentgens of whole-body irradiation 6 hours prior to sacrifice. The results demonstrate that x irradiation interferes with the incorporation of orotic acid-^{14}C into the rapidly labeled RNA. These findings were correlated with the effect of x irradiation on the biosynthesis of thymidylic kinase and DNA polymerase. (auth)

21878 THE EFFECT OF COBALT-60 ON STARLINGS (STURNUS VULGARIS VULGARIS). S. P. Garg, A. Zajanc, and R. A. Bankowski (Univ. of California, Davis). Avian Diseases, 8: 555-61(Nov. 1964).

A method employing lethal irradiation was explored for attempting to control California's increasing starling population. A baiting station could be constructed to serve as a feeding area for starlings, adjacent to a cattle feedlot, for example. This baiting station could contain a source of well-shielded radioactive material to irradiate the birds as they approached and fed upon the bait. Experiments were conducted to determine the exposure time and dose required to kill a starling. In the first experiment, adult and immature birds were exposed to 3000, 1500, 1000, 600, and 300 rad of ^{60}Co γ irradiation. For two months following exposure the birds were observed and examined daily for symptoms of radiation disease. The second experiment was conducted to determine the effects of exposure to multiple small doses of irradiation, at varying intervals, and the min lethal doses by a single exposure. Group 1 received a single exposure of 800 rad; Group 2, four exposures of 200 rad each at 24-hr intervals; and Group 3, four exposures of 200 rad each at 7-day intervals. The pattern of behavior of the starlings immediately after irradiation appeared normal. With high doses of radiation, death occurred within 48 hr, but with lower fatal doses the birds succumbed in 7 to 14 days. Exposure of 3000, 1500, and 1000 rad was 100% fatal, whereas 600 and 300 rad caused mortality of 20%. Birds that died revealed signs of severe anemia evidenced by paleness of the mucous membrane. Gall bladders were markedly enlarged. Petechial hemorrhages were found under the capsule of the spleen, and small intestines revealed mucopurulent exudate. The bone marrow of birds that died after 3000, 1500, and 1000 rad was aplastic, acellular, and hemorrhagic; those after 600 rad showed compensatory hyperplasia. Exposure to more than 1000 rad caused in spleen a total disappearance of lymphoid cells and necrobiotic changes in the reticular cells. Birds exposed to less than 1000 rad presented evidence of mass destruction of lymphoid cells, areas of thrombosis, and infarction. Duodenum showed necrosis and complete desquamation of the epithelial cells lining the villi, disappearance of lymphoid cells from the tunica propria, and extreme necrotic changes in the glandular cells in birds exposed to 1000 rad or more. The gonads were in a vestigial stage and no significant changes were noted. A total of 80 rad given in four equal doses at 24-hr intervals proved more lethal (72%) than the same amount given as a single dose (56%) or 4 equal doses at weekly intervals (16%). These histopathological studies revealed that exposure to more than 1000 rad, given as a single dose, caused severe injury to the tissues, which in most cases became irreparable. However, birds exposed to 600 and 300 rad as a single dose, showed changes leading to recovery. (BBB)

21879 A STUDY ON THE GIANT CELL FORMATION OF L-CELLS INFECTED WITH UV INACTIVATED VACCINIA VIRUS. Hiroomi Kaku and Juntaro Kamahora (Osaka Univ.). Biken's J., 7: No. 1, 37-40(Apr. 1964).

The mode of giant cell formation by vaccinia virus inactivated with ultraviolet radiation was investigated. The virus employed was the G^+HA^- substrain of vaccinia IHD. An aliquot of irradiated samples were inoculated on the monolayer culture of L-cell. After adsorption at 37°C for 1 hr the cells were rinsed and overlaid with fresh medium. The giant cell formation was observed 16 hr after infection under a microscope. It was evident that the irradiated supernatant had no effect on the giant cell formation. When the virus was irradiated at 10 ergs/mm^2/sec for 400 sec and the cells were infected with the virus at an adsorbed multiplicity of 80, larger (giant) cells than those induced by the active virus were observed. When the adsorbed multiplicity was reduced to $80/3^3$, however, there was observed no formation of giant cells. The giant cell formation by the UV-inactivated virus different from that induced by the active virus may be caused by modification of viral DNA. Thus, the giant cell formation induced by vaccinia virus infection may be caused or controlled by viral DNA. (NSA of Japan)

21880 ULTRAVIOLET LIGHT INACTIVATION OF THE PRIMING ABILITY OF DNA IN THE RNA POLYMERASE SYSTEM. Ulrich Hagen (Universitat, Freiburg i.B.), Klaus Keck, Hans Kroeger, Friedrich Zimmermann, and Theodor Luecking. Biochim. Biophys. Acta, 95: 418-25(Mar. 15, 1965).

The effects of ultraviolet light on DNA were investigated in the RNA polymerase system and by physico-chemical methods. Ultraviolet light reduces rapidly the ability of DNA to prime the synthesis of RNA. In contrast to this, the priming ability for homopolymer synthesis is destroyed at a considerably slower rate. Furthermore, irradiated DNA inhibits the synthesis of RNA which has been primed by untreated DNA. At low doses where there is already a drastic loss of the priming ability the molecular weight of the DNA is only slightly reduced. When exposed to higher levels of dosage, the DNA is denatured and a shift of the melting point is observed. Further irradiation leads to a loss of the absorption at 260 mμ. If the DNA is denatured before or after irradiation, a decrease of the absorption can be measured even in the low range of dosage indicating an alteration of the bases. The relevance of these factors—decrease of molecular weight, denaturation, and base destruction—is discussed in relation to the loss of the priming ability. (auth)

21881 THE ACTION OF IONIZING RADIATION ON THE RESPIRATORY MECHANISM OF BAKER'S YEAST. H. Lundegårdh and A. W. D. Larkum (Research Lab., Penningby, Sweden). Biochim. Biophys. Acta, 97: 422-33(Mar. 8, 1965).

The effect of x radiation on the cytochrome chain and associated systems in baker's yeast was studied by means of a specially constructed scanning spectrophotometer and by tracer technique. The basic mechanism for electron transport through the respiratory system was resistant to irradiation up to 200,000 R. An inhibition of phosphorylation was observed from 10,000 R onwards, but even the highest doses produced only 33% inhibition. Respiration was stimulated increasingly from low intensities of irradiation upwards, but irregular oxidations bypassing the important step cytochrome b-cytochrome c interfered at intensities above approximately 10,000 R. Salts (NaCl, KCl) and ADP counteracted the effects of moderate radiation on all processes, and helped counteract the irregular oxidations. At higher intensities of irradiation, some beneficial and some deleterious effects of salts and ADP were observed. The beneficial effect of ADP at moderate radiation reinforces the other observa-

tions that radiation has a greater effect on the energy converting systems than on the basic mechanism of electron transport. (auth)

21882 INVESTIGATIONS ON THE ELECTRORETINOGRAM ON THE EFFECT OF IONIZING RADIATION ON THE COMPLEX EYES OF INSECTS. Werner Nachtigall (Universitat, Munich). Biophysik, 2: 145-65(1965). (In German)

Large doses of x radiation cause radiation injury to the insect eye and at small doses x radiation acts as an irritant. A third electroretinogram (ERG) component was detected in insects by means of the x-ray-induced injury in ERG, usually formed by periodic light flashes. The insect eye responds to x-ray flashes with a ERG. This has about the same form as the light ERG, but a longer latency time than the light ERG. The threshold dose is less than 10 mr. Possible mechanisms were discussed. (tr-auth)

21883 THE EFFECT OF TOTAL BODY IRRADIATION ON THE LABELING OF CIRCULATING MOUSE LYMPHOCYTES WITH TRITIATED THYMIDINE. D. M. Whitelaw (Univ. of Toronto). Blood, 25: 749-58(May 1965).

Tritiated thymidine was administered to C3H mice at frequent intervals by intraperitoneal injection over a 2-week period. About one-third of the circulating small lymphocytes were labeled by this procedure. The animals were then exposed to 208 rads of external x irradiation which resulted in a fivefold drop in the total circulating lymphocyte count. The labeled newly formed lymphocytes and the unlabeled older lymphocytes proved to be equally sensitive to radiation. The rate of labeling of peripheral blood lymphocytes was unaffected by a single dose of radiation or by a subsequent dose delivered 4 days later. The decline in the curve of labeling, following the discontinuation of labeling with tritiated thymidine, was the same for irradiated and unirradiated mice. These experiments suggest that the output of new lymphocytes is directly related to the level of circulating small lymphocytes and may possibly depend on transformation of small lymphocytes to large proliferating cells. (auth)

21884 EFFECTS OF GAMMA RADIATION ON GERMINATION IN BRASSICA JUNCEA. C. Gomez Campo and M. E. Tortosa (Instituto Nacional de Investigaciones Agronomicas, Madrid). Bol. Real. Soc. Espon. Hist. Nat., Secc. Biol., 62: 65-71(1964). (In Spanish)

Brassica juncea an annual crucifera, is probably one of the most radioresistant plant species, as a consequence of an amphidiploid chromosomal constitution, as well as a small nuclear volume in the meristematic cells. The plant is able to grow and flower almost normally after treatment of the seed with doses up to 150,000 rads. Radiation seems to have some stimulating effect on seed germination. Also the frequency of premature germination of seeds before leaving the pod, appears strongly influenced by the radiation dose administered to the parental seeds. Irradiation of young seedlings produces a similar effect. (auth)

21885 ACUTE LEUKEMIA AFTER TREATMENT FOR HYPERTHYROIDISM WITH RADIOACTIVE IODINE. J. A. McBride (Postgraduate Medical School, London). Brit. Med. J., 2: 736(Sept. 19, 1964).

A patient who developed acute leukemia 21 months after an initial therapeutic dose of ^{131}I is described. The patient, a woman of 64, was first seen in 1959, when the diagnosis of hyperthyroidism was made. She was treated successfully with carbimazole from July 1959 to July 1960. By August 1960 the signs and symptoms of hyperthyroidism had reappeared, and she was treated with radioiodine; an oral dose of 10 mC of ^{131}I was given in September 1960. The gland uptake of this dose, however, was only 35%. In January 1961 the patient was still hyperthyroid and a further dose of 14 mC was given, of which the uptake by the gland after 24 hours was 90%. After this the patient's general condition improved considerably, but in March 1961 signs of hyperthyroidism recurred. A further dose of 9.2 mC of ^{131}I was given. By November 1961 the patient was again hyperthyroid, and 8 mC of ^{131}I was given in December 1961, with temporary improvement. By March 1962 clinical and biochemical evidence of hyperthyroidism was again noted, and a further dose of 12 mC of ^{131}I was administered. In May 1962 pulmonary consolidation was noted and a diagnosis of acute leukemia was made, death occurring in June 1962. Reports on 25 other cases of leukemia following ^{131}I therapy are reviewed. In the present case the activity of the thyroid gland was exceptionally resistant to treatment and the total dose of radioiodine given was much greater than is usually used in the control of hyperthyroidism. With the exception of the first dose the uptake of the iodine by the thyroid was satisfactory. It is noted that leukemia has also been reported in patients with carcinoma of the thyroid who have been treated with comparatively large doses of ^{131}I. Ten such cases in the literature are reported to have developed acute leukemia. (BBB)

21886 HISTOLOGICAL CHANGES IN THE RAT BONE AFTER VARYING DOSES OF X RAYS WITH PARTICULAR REFERENCE TO BONE TUMOUR PRODUCTION. J. P. M. Bensted and V. Doreen (Royal Cancer Hospital, Belmont Surrey, Eng.). Brit. J. Radiol., 38: 261-70(Apr. 1965).

The histological changes and production of bone tumors were studied in the hind limbs of some 257 rats after doses of x rays of 500 to 3,000 R. In some cases the 3,000 R was divided into three doses of 1,000 R or six doses of 500 R. The greatest number of tumors was found in the highest dosage groups, though with 500 R there was one bone tumor. The epiphyseal plate showed marked changes including transverse splitting. Peritrabecular fibrosis only occurred in the 3,000 R group and there was no evidence to connect either this change or epiphyseal plate changes with the subsequent development of tumors. It is suggested that two different mechanisms may be operating in the single and fractionated dosage groups. (auth)

21887 THE EFFECT OF A SINGLE 2,000 R EXPOSURE OF X RAYS UPON THE UPTAKE OF ^{35}S BY SOFT TISSUES OF THE MOUSE HIND LIMB. C. W. Wilson (Westminster Hospital, London). Brit. J. Radiol., 38: 271-7(Apr. 1965).

The effects of a single 2,000 R exposure of 200 kvp x rays on the ^{35}S uptake by the soft tissues of the mouse hind limb were examined throughout a period of up to 23 weeks following irradiation. The normal ^{35}S uptake by the soft tissues fell off with time via three components of half-lives three quarters of an hour, five hours, and 60 hours, respectively. The effects produced by the irradiation upon the first component were relatively small. It is possible, however, that the irradiation produces two slight waves of uptake depression and elevation during the first 14 weeks after irradiation and then the uptake remains at a slightly depressed (80% of normal) value from 14 to 23 weeks after irradiation. Irradiation effects were most marked in the second component of isotope loss. In this case, after a small, possibly not significant fall produced during the first four to five weeks after irradiation, the ^{35}S uptake rose continuously to more than three times the normal level at about 15 weeks after irradiation. The uptake then fell slowly but was still more than twice normal 23 weeks after irradiation. Effects produced in the third component were very small and may not be significant. Certainly little or no effect was produced during the first seven weeks after irradiation. A very slight rise of ^{35}S uptake (about 20%) may have occurred by nine or ten weeks post-irradiation and this may be followed by a slow steady fall to about 80% of normal uptake at 23 weeks post-irradiation. The use of the effect upon the second component is discussed in relation to possible future studies concerning the effect of age of animal, total dose given, dose fractionation, etc. The possible significance of the results and their relation to those found for the mouse knee joint are also discussed and it is suggested that quantitative biochemical studies of the tissue mucopolysaccharides following irradiation of the tissue would be of value. (auth)

21888 EXPERIMENTS WITH FRACTIONATED X-IRRADIATION OF THE SKIN OF PIGS. II. FRACTIONATION UP TO FIVE DAYS. J. F. Fowler, D. K. Bewley, R. L. Morgan, and J. A. Silvester (Hammersmith Hospital, London). Brit. J. Radiol., 38: 278-84(Apr. 1965).

Fifteen fields on one pig were irradiated with 1, 2, 2, 3, and 5 fractions in 1, 5, 2, 3, and 5 days, respectively. Skin reactions were recorded up to 80 or 100 days, so that the doses that produced equal reactions could be assessed. Three degrees of damage were analyzed for early, medium, and late reactions. As an example, the doses to produce one level of reaction over 30–85 days were respectively, 2,050, 2,560–2,750, 2,750, 3,360 and 4,060 Rads for the fractions listed above. The corresponding values of $D_0 = (D_n - D_1)/n-1)$ were high, 500–700 Rads. The values of $(D - D_1)/(n-1)$ became smaller with larger numbers of fractions. Two pigs were irradiated to investigate the reciprocal vicinity effect. It was found to be small for the field arrangements used, but the sensitivity of pig skin increased in the dorso-ventral direction and corrections were sometimes necessary. Two pigs were irradiated with pairs of equal doses separated by 0 to 24 hours. A recovery pattern was observed similar to that found in cell culture by others, but less well resolved. It is not established that skin damage is entirely due to loss of cellular reproductive integrity, but from the practical point of view the empirical relation between dose and skin damage in pigs was similar to that found in patients, and was in agreement with other work on mouse skin and mouse intestinal death, but not with cell survival work on hemopoietic cells. (auth)

21889 STUDIES ON THE FAVORABLE EFFECT OF POSTIRRADIATION BLEEDING ON HEMATOPOIESIS AND SURVIVAL. III. THE EFFECT OF POSTIRRADIATION BLEEDING ON THE REGENERATION OF BONE MARROW CELLS IN MICE. S. Hajdukovic, N. Petrovic, V. Ninkov, and D. Raskovic. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 155-61(July 1963).

The effect of irradiation and post-irradiation bleeding on the regeneration of bone marrow cells in C57B1 mice was studied. The results showed that the bleeding of irradiated mice (within the lethal dose range) increases the mitotic activity of bone marrow cells. (auth)

21890 THE EFFECT OF POST-IRRADIATION BLEEDING ON THE HEMATOLOGICAL REGENERATION AND SURVIVAL OF IRRADIATED MICE. S. Hajdukovic, V. Ninkov, N. Petrovic, D. Raskovic, and Lj. Petrovic. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 243-52(Oct. 1963).

The effect of post-irradiation bleeding on the elements in the peripheral blood and bone marrow and on the survival of mice exposed to x rays of 600 and 700 R was investigated. The results indicated a faster hematological regeneration in irradiated and bled animals as compared to irradiated controls. (auth)

21891 THE EFFECT OF IONIZING RADIATION ON THE NEUROSECRETION OF SUBTHALAMIC NUCLEI. L. A. Andrianova. Byul. Eksperim. Biol. i Med., 59: 33-6(Jan. 1965). (In Russian)

The effect of ionizing radiation on the neurosecretion of the nuclei of the subthalamic area was investigated in rabbits subject to gamma irradiation with a total dose of 400 R. An increase of neurosecretory substance was revealed 3 hours after irradiation of cells of the supraoptic and paraventricular nuclei. There was a reduction of secretion on the first and third days. Aminazine was administered to animals to ascertain the irradiation mechanism on the neurosecretory process. This agent eliminated the effect of increased secretion in the subthalmic nuclei, which was possibly associated with the blocking action of aminazine on the adrenergic systems of the reticular formation. (tr-auth)

21892 THE 24-HOUR RHYTHM OF MITOTIC ACTIVITY IN THE REGENERATING LIVER DURING ACUTE RADIATION SICKNESS. V. I. Bulgak (Inst. of Experimental Med., Leningrad). Byul. Eksperim. Biol. i Med., 59: 90-3(Jan. 1965). (In Russian)

A study was made of the 24-hour rhythm in the mitotic activity of hepatic cells and in the percentage of binuclear cells in the regenerating liver of rats following a single total exposure to x irradiation at a dose of 600 R. At the peak of acute radiation sickness the 24-hour mitotic rhythm was retained. As in the case with reparative and physiological regeneration in nonirradiated animals the peak of mitotic activity occurred during the early morning hours. The mean 24-hour coefficient of the cell mitotic activity 2 to 3 days following operation and correspondingly 5 to 6 days following irradiation did not diminish as compared to control. No regularities were revealed that would suggest that during the 24-hour period the number of binuclear cells in irradiated and nonirradiated rats was changed. (tr-auth)

21893 KARYOKINESIS OF SOMATIC NUCLEI OF NEUROSPORA CRASSA. I. THE CORRECTION BETWEEN CONIDIAL RADIOSENSITIVITY AND THEIR KARYOKINETIC STAGE. D. L. Weijer (Univ. of Alberta, Edmonton). Can. J. Genet. Cytol., 6: 383-92(Dec. 1964).

The radiosensitivity of the conidia of Neurospora crassa was assessed in terms of conidial kill following irradiation at different time intervals after commencement of incubation. Samples were also removed and stained (Feulgen) for cytological observations of the karyokinetic stages under aerobic conditions. The conidial suspensions of the wild type 74A strain were x irradiated at a rate of 20 R/sec to a total dose of 10,000 R. The suspension was then plated on a minimal agar medium supplemented with L-sorbose. A significant increase in radiosensitivity of conidia (precooled for 120 hr at 4°C prior to incubation at 30°C) was observed at 135, 180, and 225 min of incubation at 30°C prior to irradiation. A second increase in radiosensitivity occurred at 315 min of incubation at 30°C prior to irradiation. Using conidia raised and stored at 30°C prior to the experiment (i.e., nonprecooled conidia) an almost identical curve for conidial kill after irradiation with 10,000 R was obtained. However, in the latter case, the increase in radiosensitivity commenced after 45 min of incubation at 30°C prior to irradiation rather than at 135 min. Simultaneous cytological observations on specimens of germinating conidia revealed that an almost completely synchronous karyokinesis commenced (96% of all macro- and microconidia) after 45 min of incubation, as measured by the appearance of filament phase. Conidiophore and hyphal fragments, on the other hand, are not in phase with the synchronous conidial karyokinesis. They show more advanced karyokinetic configurations and are, therefore, preceding the conidia in their nuclear division. DNA replication in well-aerated conidial suspensions in minimal medium, took place within the first 6 hr of incubation at 30°C, i.e., during filament and ring phase. The appearance of these latter cytological phases was found to be paralleled by an increase in radiosensitivity measured in terms of conidial kill. Although conidial kill as a result of x irradiation is not solely due to a lethal nuclear event but is also due to somatic effects, the fluctuation in the percentage of conidial death appears to be due to a fluctuation of radiosensitivity of the nucleus. The conidium does not produce a hyphal germination tube until after the seventh hr of incubation (i.e., the target size of the conidium remains unchanged during the first seven hr). The nucleus, on the other hand, undergoes rapid changes with respect to shape and DNA content. The conidiophore and hyphal fragments do not contribute to the percentage of conidial kill. Their nuclear content is so extensive, that even x-ray doses in excess of 80,000 R will not render them inactive. (BBB)

21894 BOUND WATER, INOSITOL, AND THE EFFECT OF X-RAYS ON ESCHERICHIA COLI. S. J. Webb and M. D. Dumasia (Univ. of Saskatchewan, Saskatoon, Can.). Can. J. Microbiol., 10: 877-85(Dec. 1964).

Aerosols of Escherichia coli B were subjected to 250 kv x rays. It was found that maximal x-ray damage occurred at 70 to 80% relative humidity (R.H.). At these R.H. values only the water bound directly to cell macromolecules remains, and if the water layers were increased by using higher humidities, x-ray damage decreased. Also, at R.H. levels below 70% a sharp decrease in the sensitivity of the cells to the radiation occurred. Several chemicals known to protect cells against desiccation, ultraviolet, and x-ray damage were examined and of these i-inositol proved the most successful. The difference in the protective ability of these various compounds indicated that some protect

cells against desiccation damage by retaining water, others by replacing bound-water molecules in macromolecular structure but those retaining water will not protect against x rays. The results suggest that the physical removal or ionization of a strategic bound-water molecule by x rays causes most of the cell deaths rather than ionizations occurring in the free water as the presence of the latter appears to offer cells a measure of protection. (auth)

21895 CONGENITAL ABNORMALITIES IN CHILDREN BORN IN ALBERTA DURING 1961: A SURVEY AND A HYPOTHESIS. L. J. le Vann (Provincial Training School, Red Deer, Alberta). Can. Med. Assoc. J., 89: 120-6 (July 20, 1963).

The incidence of congenital malformations in children born in Alberta in 1961 was 13.8 per 1000 births; this was considerably higher than in 1959 (7.6 per 1000 births). The ingestion of drugs by the mother during pregnancy did not appear to be a major cause of these malformations. The only constant factors recognized to have a relation to the abnormal births were: (1) the geographic area where the child was born and (2) the precipitation levels of that area. In Alberta, precipitation and its runoff are quite different from many other areas in Canada. There is more precipitation in the province's northern regions than in the south. Also, precipitation occurring during the last three months of the year usually accumulates during the winter months, remaining for a further three or four months of the subsequent year as ice or snow, until its runoff in the spring. This usually occurs as much as six weeks later in the northern part of the province than in the south. A higher incidence of malformations per 1000 births in the northern part of the province than in the southern part was apparent. The hypothesis is advanced that because of the higher levels of rainfall in 1961 and its contamination by radioactive fallout, more babies may have been subjected to exposure from radioactive elements in utero. Births in 1962 will, it is postulated, show even higher rates of abnormalities per 1000 births because of an increased concentration of radioactivity in the stratosphere, as a result of intensive above-ground explosions in the Soviet Arctic and sub-Arctic throughout 1959 and 1962. (BBB)

21896 EFFECT OF THYMECTOMY ON INDUCTION OF TUMORS AND ON THE TRANSPLANTABILITY OF POLYOMA-INDUCED TUMORS. V. Defendi and R. A. Roosa (Wistar Inst. of Anatomy and Biology, Philadelphia). Cancer Res., 25: 300-6(Apr. 1965).

The influence of thymectomy on tumor induction by polyoma virus and on the transplantability of polyoma-induced tumors in hamsters and mice was investigated. Animals were thymectomized either within 24 hr after birth or at 7 days; in the latter case, they were given 350 R total body x irradiation 1 week later. Controls consisted of sham and nonoperated animals. The inoculation of polyoma virus 7 days after neonatal thymectomy in hamsters resulted in the early appearance of tumors and in a higher incidence of tumors per animal. Inoculation into neonatally thymectomized hamsters at 3 to 4 months of age produced tumors in 85% of the animals versus 35% of the controls. Here again tumors were multiple in the thymectomized group; when present in the controls, tumors appeared only at the site of inoculation. Mice immunized with polyoma virus were resistant to the challenge of polyoma-induced tumor cells. When this experiment was performed with thymectomized C3H/Bi and C57/BL/6J mice it was possible to demonstrate almost complete abolition of resistance to an inoculum of 10^5 isologous polyoma-induced tumor cells. In addition, 7 out of 18 thymectomized and x irradiated C57/BL/6J mice, inoculated with polyoma virus as late as 2 months of age, developed primary tumors within 4 months. The serum titer against polyoma hemagglutinating activity in all the thymectomized groups was either slightly lower than or equal to that of the controls. On the basis of these results it is suggested that neonatal thymectomy enhances tumorgenicity of polyoma virus by depressing the immunologic response to the polyoma-induced tumor cell antigen(s). (auth)

21897 EFFECT OF DELAYED ADDITION OF IRRADIATED CELLS TO SMALL VIABLE TUMOR INOCULA. A. C. Wallace (Univ. of Manitoba, Winnipeg, Can.). Cancer Res., 25: 355-7(Apr. 1965).

The stimulating effect of a large inoculum of heavily x irradiated cells on the growth of a small viable tumor inoculum was used as a means of attempting to demonstrate dormancy of C3HBA tumor cells in C3H mice. The irradiated supplement was injected mixed with the viable cells, and also separately at intervals varying from a few minutes to several days after the viable cells. All inoculations were made I.M. and the delayed irradiated inocula were placed as close as possible to the viable inocula. It was found that injection of viable and irradiated cells separately always reduced the number of takes as compared with simultaneous injection, but some tumors always appeared when the supplement was given within 24 hr. No tumors arose when the irradiated cells were injected later than this; thus this study failed to demonstrate that viable cells remained dormant for a prolonged period of time. (auth)

21898 CHANGES IN DISTRIBUTION OF SOME DRUGS IN ORGANISM AFTER IRRADIATION. V. Grossmann, and V. Lonska (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 13: 515-16(Dec. 1964).

The distribution of pethidine, norpethidine, rhodanide, hexorbital, and some other drugs was studied. An increased level of cation drugs and decreased level of anion drugs was found after irradiation. In the first 20 minutes the level of penicillin decreased and of streptomycin increased; the difference disappeared with time. (CFSTI)

21899 REGENERATION OF IRRADIATED MEMBERS IN AXOLOTL, INDUCED BY GRAFTS OF TESTICLE. Lieba Lazard (College de France, Paris and CNRS, Paris). Compt. Rend., 260: 1277-9(Jan. 25, 1965). (In French)

Members of Axolotl, exposed to a suitable dose of x rays, are incapable of regeneration. These can be restored by a preliminary graft of a testicle fragment of the same species. The regenerates thus obtained are frequently abnormal, sometimes incomplete, and sometimes hypermorphic. A second amputation suppresses these anomalies in the secondary regenerates. (tr-auth)

21900 RADIORESISTANCE OF THE LIMULE XIPHOSURE POLYPHEMUS L. AND MODIFICATIONS OF ITS NUCLEIC ACIDS AFTER X AND γ IRRADIATION. Pierre Niaussat, Max Vachon, John H. Ebersole, Alain Soisson, and Claude Grenot (Naval Medical Research Inst., Bethesda, Md.). Compt. Rend., 260: 1795-8(Feb. 8, 1965). (In French)

Mature and immature individuals of a panchromic marine species of Arthropoda, Xiphosura polyphemus (L.), were exposed to variable doses of irradiation. A marked radioresistance, observed principally in mature specimen, seemed higher when the animals are maintained under conditions inducing a low metabolic activity. This radioresistance is, however, less than that of scorpions of the desert regions. The irradiation induces in the Limule a marked drop of nucleic acids, especially the DNA of the hemolymph. (tr-auth)

21901 EFFECT OF THE GENOTYPE OF THE HOST BACTERIA ON THE MUTATION OF THE λ PHAGE PRODUCED BY ULTRAVIOLET RADIATION. Raymond Devoret (CNRS, Gif-sur-Yvette, France). Compt. Rend., 260: 1510-13(Feb. 1, 1965). (In French)

Mutations appear in λ phage when they are multiplied in a bacteria that has been previously exposed to ultraviolet radiations. It is shown that these mutations are not produced when the irradiated bacteria is genetically incapable of assuring the "reactivation by the host". As this is notably connected to the presence of an enzyme that controls some radiolesions of the bacterian DNA, the hypothesis is formulated that the mutation is the result of the incorporation in the DNA of the phage during multiplication of degradation products coming from the irradiated DNA of the host bacteria. (tr-auth)

21902 II. DEFINITION OF THE RADIATION COMPLEX. A. THE CHARACTERIZATION OF RADIATION. Marshall Brucer. Conn. Med., 28: 171-80(Mar. 1964).

The nature of ionizing radiation is outlined with reference to 12 characteristics, including dose, dose rate, energy, number of exposures, duration, fractionation, age of subject, organ irradiated, and the effects of radiation. In the concept presented, each of these 12 separate characteristics has one dimension. The same 12-dimensional picture is said to fit exposure to any object; thus a Geiger-Mueller tube responds to radiation according to a pattern of about 12 characteristics. It has limitations in dose, rate, energy, number of radiating events, and their duration and interval. A Geiger-Mueller tube has an age and a state of health, but not quite in the same human body sense. Some parts are more susceptible to exposure than others. A two-dimensional graph can be used to illustrate each of the characteristics mentioned, but it is not possible to draw a 12-dimensional graph. Four three-dimensional graphs are drawn to show that every kind of radiation exposure can be distinguished in one way or another from every other kind of a radiation exposure. The first three characteristics, for example, relate to the dose of radiation; the second three relate to the time during which radiation is being applied; the third three relate to the exposure of the body; and the fourth three relate to the effect of the exposure. These are not 12 separate graphs; they are all one graph, separated only for convenience. In this three-dimensional presentation, the first three characteristics, for example, are placed upon a three-dimensional coordinate system. The total dose in rads is put on the vertical coordinate. On the A (vertical) axis there may be either a very small amount of radiation (minus) or a very large amount of radiation (plus). The rate at which the radiation is applied may either be very slow (minus) or very fast (plus). This is put on one horizontal coordinate (B axis). On the other horizontal coordinate (C axis) may be put the energy of the radiation expressed as a tenth-value layer. A table lists 6 kinds of radiation exposure using gross measurements of the characteristics. These are plotted on the 12-dimensional graph (four three-dimensional graphs), showing that, using only the grossest measurements, there are over 1500 kinds of exposure. These concepts are used to characterize types of radiation accidents, as well as the degree and effects of acute lethal radiation exposure in man. (BBB)

21903 CHROMOSOMES OF HUMAN THYROID TUMORS. E. L. Socolow, E. Engel, Linda Mantooth, and J. B. Stanbury (Harvard Medical School and Massachusetts General Hospital, Boston). Cytogenetics, 3: 394-413(1964).

Cytogenetic studies of one malignant and five benign human thyroid tumors grown in tissue culture are presented. In a follicular adenocarcinoma, a hyperdiploid stemline with supernumerary chromosomes in all groups was found. Abnormal chromosomes were not seen. In four of the adenomas studied, most of the cells had a normal chromosome complement. A history of prior x irradiation to the face and neck was obtained from a fifty-four-year-old patient with a histologically benign microfollicular adenoma. Almost all of the cells had 46 chromosomes, but only a few had a normal karyortype. The majority had a pseudodiploid chromosome complement due to either loss of acquisition of members of various groups, or the presence of abnormal chromosomes of varying size and configuration. (auth)

21904 EFFECT OF FRACTIONATION OF IRRADIATED DOSE OF Co^{60} γ-RAYS ON THE FISH, ORYZIAS LATIPES. Hisami Eto (National Inst. of Radiological Sciences, Chiba, Japan). Dobutsugaku Zasshi, 74: 29-30 (Jan. 1965). (In Japanese)

When the adults of Oryzias latipes were subjected to a single dose of 100 kr of ^{60}Co γ rays, all the irradiated fish died immediately after the exposure, but they survived for a period of about 10 days after irradiation with 50 kr. Fourteen groups composed of 23 to 27 individuals each were subjected to 100 kr of γ rays, delivered in two equal doses of 50 kr separated at various time intervals, 2 and 10 minutes and 1, 5, 24, and 72 hours, respectively. In experiments keeping the fish at 23°C during the interval, all groups, except the 72 hour interval group, died just after the second irradiation. However, when the interval was prolonged to 72 hours at 23°C, the survival curve similar to the case of a single dose of 50 kr was obtained. If kept at lower temperature (11°C) during the interval of 72 hours, all the individuals died just after the irradiation. From these data, it was concluded that the rate of the recovery process from injury after a massive dose of irradiation is likely to depend on temperature. (NSA of Japan)

21905 SKIN GRAFTING FOLLOWING EXCISION OF A DEEP BURN WOUND IN ANIMALS WITH ACUTE EXPERIMENTAL RADIATION SICKNESS. S. Z. Zalyalyutdinova. Eksperim. Khirurg. i Anesteziol., No. 5, 45-7(1963).

In experiments carried out on 45 rabbits, the animals of group I were subjected only to third-degree thermal burns while those of group II were irradiated once with a dose of 900 to 1050 R x radiation and then subjected to thermal burns. Three days later the burn wound was debrided and covered with a skin autograft or homograft. The homografts took only after 3 to 5 days and were eventually rejected, healing being by secondary reaction. Complex surgical and general supportive therapy of the burn wounds decreased the mortality rate. The author concludes that autografts are the only effective method of treatment of deep burn wounds in irradiated animals. (CFSTI)

21906 MERISTEMS AND THE EFFECT OF RADIATION ON CELLS. F. A. L. Clowes (Oxford Univ.). Endeavour, 24: 8-12(Jan. 1965).

Results are reported from studies of the effects of 1800 rads and 360 rads x radiation on the growth of cells in meristems of Zea mays root tips. Data are included from studies on radiation effects on the synthesis of DNA in which tritium-labeled thymidine was used as a tracer. The control of organization during plant growth is discussed. (C.H.)

21907 ON THE PHAGOCYTOSIS OF RADIATION-INJURED LYMPHOCYTES OF THE THYMUS. H. Klug (Charite-Geschwulstklinik, Berlin). Experientia, 21: 129-30(1965). (In Germany).

Part of the lymphocytes of the thymus were phagocytized by epithelial and mesenchymal reticular cells in rats after x irradiation of the whole body. The intracellular decomposition is obviously brought about by the two cellular forms in a different way. Pearl-string-like structures, probably nucleoproteids, were found in the cytoplasm in the case of the epithelial cells. On the other hand, numerous cytoplasmic inclusions of different size, which are evidently reduced lymphocytic nuclei, could be observed in the case of the mesenchymal cells. (tr-auth)

21908 EFFECT OF INTERNAL RADIOPHOSPHORUS IRRADIATION ON THE OVARY OF PUNTIUS SOPHORE HAMILTON. P. N. Srivastava and S. K. Rathi (Univ. of Rajasthan, Jaipur, India). Experientia, 21: 133-4(1965).

The effect of internally-injected ^{32}P on the morphology of developing oocytes was studied in the annual-breeding fish, Puntius sophore. Phosphorus-32 was injected intraperitoneally while the ova were in the first two stages of development. The effect of B radiation was maximum on the 7th post-injection day. Morphological changes observed included mononucleated, binucleated, and multinucleated giant cells and the appearance of giant nuclei and aggregations of ova. (C.H.)

21909 THE EFFECTS OF X-RADIATION ON LACTATE METABOLISM OF MAMMALIAN CELLS. J. F. Whitfield, H. Brohee, and T. Youdale (C.C.R. Euratom, Ispra, Italy). Expti. Cell Res., 37: 637-49(Mar. 1965).

There were two distinct phases of lactate production in suspension cultures of x irradiated (1500 R) rat thymocytes. Lactate was produced during the first hour after irradiation. Production then stopped only to resume after 3 hr. Unirradiated cells did not produce lactate after an initial production during the isolation procedure. The first phase of lactate production in irradiated cultures was probably a

combined result of the isolation trauma and exaggeration of this trauma by radiation. The second phase followed the disappearance of the characteristic reticulo-granular chromatin structures of the nucleus and the disappearance of stainable DNA-associated histone. These cytological symptoms accompany cell death. In a medium without phosphate, the postirradiation development of cytological damage was inhibited and the cells consumed the lactate produced during isolation instead of making more. In the presence of phosphate, there was a strong stimulation of lactate production and development of cytological damage by irradiation. Exposure of cells to spermidine (0.10 M) or a high Na^+ concentration (260 mEq/l) immediately after irradiation strongly retarded the development of cytological damage, but they did not retard lactate production. These agents strongly stimulated lactate production in unirradiated thymocyte cultures. Exposure of thymocytes to 0.10 M nicotinamide from 0 to 3 hr after irradiation prevented further development of cytological damage and further production of lactate. Irradiation (1500 and 1700 R) of suspension cultures of the more radioresistant L mouse cells which rapidly consume lactate during the later phases of growth resulted in a transient inability to consume lactate. The cells fully regained their ability to consume lactate 8 to 16 hours after irradiation. Possible mechanisms underlying these initial metabolic effects of irradiation are outlined and discussed. (auth)

21910 REACTION OF THE NEURAL ELEMENTS OF THE GASTROINTESTINAL TRACT TO THE RADIATION EFFECT DUE TO TOTAL X-RAY IRRADIATION. Z. Ya. Tkachenko (Bogomoletz Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 11: 104-10(Jan.-Feb. 1965). (In Ukrainian)

The method of detecting neural elements by impregnation with silver salts and staining the tunics of pulpous fibres by Spielmeyer's method was used on 18 rabbits, subjected to total-body x irradiation with a dose of 1100 R, to trace the state of the neural elements of various areas of the digestive tract. As a result of the investigations it was found that in various parts of the digestive tract the reaction of the neural elements to the radiation effect is not the same. The greatest changes were detected in the neural plexuses of the esophagus and stomach, expressed in reactive, dystrophic, and destructive processes, while in the other investigated areas of the gastrointestinal tract reactive alterations predominated. In the plexuses of the esophagus and stomach dystrophic and even destructive changes were encountered along with reactive alterations. At subsequent periods after irradiation dystrophic changes increased in all areas, as a result of which some of the neural elements proved to be in a state of destruction. (tr-auth)

21911 EFFECTS OF IRRADIATION ON POLLEN. PART II. Yozo Iwanami (Yokohama Municipal Univ., Japan). Gamma Field Symp., No. 2, 53-66(Sept. 1963).

The effects of pollen irradiation on pollen germination, tube elongation, starch formation, and starch digestion in pollen grains, diversion of generative nucleus and production of seeds were investigated. Although some of these results have been reported elsewhere (Iwanami and Matsumura 1962), they are described here. (A.G.W.)

21912 SOMATIC MUTATION STUDIES ON COSMOS BIPINNATUS WITH PARTICULAR REFERENCE TO INDUCTION OF FLOWER COLOR CHANGES. Mahendra Nath Gupta* and Yoshihiko Samata (*National Botanic Garden, Lucknow, India). Gamma Field Symp., No. 2, 69-76(Sept. 1963).

Two clones of Cosmos bipinnatus, which are heterozygous in flower color, were used in these experiments. Acute x-ray and chronic γ irradiation were given at different stages of development. Mutations appeared as streaks of different colors from the normal background color. Irradiation at younger stages of bud produced fewer but wider streaks, while irradiation at more advanced stages produced more but narrower streaks. The mutation rate was remarkably low in γ irradiation as compared with acute x irradiation at corresponding doses. (auth)

21913 DIFFERENCES IN RBE OF GAMMA-RAYS AND FAST NEUTRONS IN THE POLYPLOID WHEAT SERIES. Seiji Matsumura (National Inst. of Genetics, Misima, Japan). Idengaku Zasshi, 39: 86-90(Sept. 1964).

Results are reported from studies on differences in the relative biological effectiveness (RBE) of x, gamma rays, or neutrons, or differences in the radiosensitivity of related plants forming polyploid series. Preliminary data are presented on di-, tetra-, and hexaploid wheats, exposed to thermal and 14-Mev neutrons. The growth of seedlings, seed fertility of treated X_1 plants, and chlorophyll mutation of X_2 seedlings were compared for gamma and 14-Mev neutron exposures. The materials used in this study were Triticum monococcum L. var. flavescens Körn., a diploid species with n = 7, T. durum Desf. var. Reichenbachii Körn., a tetraploid species with n = 14, and T. vulgare Vill. var. erythrospermum Körn., a hexaploid species with n = 21. They had been maintained for a number of years in homozygous condition. (C.H.)

21914 RADIATION EFFECTS ON ARABIDOPSIS THALIANA. I. COMPARATIVE EFFICIENCIES OF γ-RAYS, FISSION AND 14 Mev NEUTRONS IN SOMATIC MUTATION. Taro Fujii (National Inst. of Genetics, Misima, Japan). Idengaku Zasshi, 39: 91-101(Sept. 1964).

Relative biological effects (RBE) of fission and 14 Mev neutrons with respect to γ rays were studied in Arabidopsis thaliana, an autogamous crucifer, by specific locus method. F_2 seeds from the cross between the single recessive hairless mutant and the wild hairy strain (race Landsberg) were used in this experiment, because of the difficulty to obtain many F_1 seeds. Dry seeds were subjected to 1.2, 2.1 and 2.9 krad of fission neutrons and to 0.8, 1.9, 2.6, and 4.4 krad of 14 Mev neutrons; 23.6 to 47.3 krad of γ irradiations were also carried out in each neutron experiment. Experiments were carried out under continuous light in an air-conditioned room. Around 90 per cent of seeds germinated in the controls and in all γ ray and neutron lots. Almost all seedlings survived. During the growth of seedlings, segregation ratio of hairless homozygotes was examined. They segregated according to the ratio of 3 : 1 in all lots. Therefore, hairy plants must have consisted of $\frac{1}{3}$ dominant homo- and $\frac{2}{3}$ heterozygotes. Should somatic mutation from dominant hairy to recessive hairless occur in heterozygotic seeds, it would appear on some part of the plant body. Some of hairy plants in the irradiated lot had some leaves or parts of leaf without hairs. The frequency of plants with hairless sectors increased with increasing dosage both in γ ray and neutron lots. A non-linear relation taking rather the shape of an exponential curve, was observed for the γ ray group, whereas the frequency versus neutron dosage was nearer to linear relationship. Hence RBE of neutrons depends on dosage or frequency. The very rough estimate of the RBE for somatic mutation at 1 per cent frequency is about 15 and 16 for 14 Mev and fission neutrons, respectively. The possibility that the mutation is caused by chromosomal aberrations is discussed. (auth)

21915 RELATIVE BIOLOGICAL EFFECTIVENESS OF 14 Mev NEUTRONS TO γ-RAYS FOR INDUCING MUTATIONS IN SILKWORM GONIA. Akio Murakami and Sohei Kondo (National Inst. of Genetics, Misima, Japan). Idengaku Zasshi, 39: 102-14(Sept. 1964).

Comparative investigations were made of the effectiveness of 14 Mev neutrons and ^{137}Cs γ rays in the induction of visible recessive mutations in early and in late gonial cells of the silkworm. Dose-frequency curve for each of these two radiation experiments was obtained. The curves are qualitatively similar, each showing an initial linear part followed by an exponential rise with increasing dose. This was explained by assuming that mutations scored at lower doses and constituting the linear part of the curves are due to single hits, whereas those recovered at higher doses and forming the exponential part of the curve are caused by multi-hit events. Dose-frequency curves for 14 Mev neutrons showed that the drop in mutation appears

at doses beyond about 2,000 rad for early and late spermatogonia and late oögonia. The data on the mutation drop fit to the selective killing hypothesis. Mutation frequencies recovered after exposure to 14 Mev neutrons were more or less similar between the two, early and late groups, for both sexes in the dose range below 1,000 rad, but in the dose range above 1,000 rad they were much higher for the late than for the early group. The mutation frequencies in late gonia were higher for 14 Mev neutrons than γ rays, while in early gonia they were almost equal for both. The RBE of neutrons to γ rays was found to depend sensitively on the germ cell stage; it was about 1 for early gonia and 2 to 3 for late gonia, when comparisons were made at the level of 10^{-3} mutation frequency. The variation in RBE is due to the variation with stage in frequencies of acute γ ray-induced mutations. (auth)

21916 CONTRIBUTION FROM 14 Mev NEUTRON EXPERIMENTS TO THE INTERPRETATION OF THE MECHANISMS OF DOSE-RATE EFFECTS ON MUTATION FREQUENCY IN SILKWORM GONIA. Yataro Tazima (National Inst. of Genetics, Misima, Japan). Idengaku Zasshi, 39: 115-19(Sept. 1964).

Results are summarized from a series of studies on the mechanisms of dose-rate effects on mutation frequency in silkworm gonia. Data are reported on the effects of chronic and acute exposure to various doses of x, γ, and 14 Mev neutrons on mutation frequencies induced by exposure at different larval stages. (C.H.)

21917 RELATION OF RADIATION EFFECTS TO DOSE RATES OF GAMMA- OR X-RADIATION IN RICE AND WHEAT. Seiji Matsumura and Tomoo Mabuchi (National Inst. of Genetics, Misima, Japan). Idengaku Zasshi, 39: 120-30(Sept. 1964).

Results are reported from comparative studies on the effects of acute and chronic doses of x and γ radiation on growth, survival, fertility, and mutation induction in rice, Oryza sativa, and wheat, Triticum monococcum, grown from seeds exposed in the dry state. Total radiation dose and dose rates were varied. The possibility that the effect of irradiation on dormant seeds may continue after the irradiation ends is discussed. (C.H.)

21918 DOSE RATE DEPENDENCE OF MUTATION RATES FROM γ-IRRADIATED POLLEN GRAINS OF MAIZE. Tomoo Mabuchi and Seiji Matsumura (National Inst. of Genetics, Misima, Japan). Idengaku Zasshi, 39: 131-5(Sept. 1964).

A recessive line of Golden Cross Bantam corn and a dominant line of another variety with respect to the sugary endosperm gene (Su-su), which is located on the short arm of chromosome 4, were crossed. Pollen grains or whole tassels before dehiscence of the dominant line (Su) were irradiated by gamma-rays and dusted on the ears of the recessive line. Chronic irradiation (1.25 R/min) was applied only to the tassels before dehiscence with gamma rays from a ^{137}Cs source (6,000 curies), with 46 mm Pb filter, at 80 cm distance for 6 to 20 hours at 500 to 1500 R. Acute irradiation (917 R/min) with gamma-rays, without filter, 20 cm distance for 36 to 108 seconds at 550 to 1650 R was given to scattered pollen grains and to tassels before anther dehiscence. The irradiated tassels in the acute irradiation were stored for 14 to 16 hours. Data on mutation frequency were analyzed. Results indicate that mutation of endosperm characters from pollen treatment with γ radiation is, as a rule, induced by chromosome aberrations. (C.H.)

21919 ULTRAVIOLET-INDUCED PHOTOREVERSIBLE GENETIC CHANGE OBSERVED IN HETEROZYGOUS DIPLOID SYSTEM OF YEAST—A STUDY OF THE UV ACTION SPECTRUM FOR INDUCTION AND OF THE PHOTOREVERSION. Takashi Ito, T. Yamasaki, M. Domon, S. Ishizaka, and Y. Matsudaira (Rikkyo (St. Paul's) Univ., Tokyo). Idengaku Zasshi, 39: 136-46(Sept. 1964).

The nature of genetic changes inducible by uv in diploid yeast was studied through the action spectrum for the induction and photoreversion experiments. The uv action spectrum for the induction was found to be similar to the absorption spectrum of thymidine in shape. Eighty per cent of the effect by 2,800 Å radiation is photoreversed. Therefore, the primary events for both the induction and the photoreversion process may be explained by the double-strandedness of the gene DNA, although the kinetics of the photoreversion of whole- and fractional-type of change is not sufficiently clear. (auth)

21920 THE WHOLE- AND FRACTIONAL-COLONY MUTATION INDUCED BY SOFT X-RAYS IN YEAST. Terutoshi Yamasaki, Takashi Ito, and Yoriaki Matsudaira (Rikkyo (St. Paul's) Univ., Tokyo). Idengaku Zasshi, 39: 147-50(Sept. 1964).

Evidence is presented for whole- and fractional-colony mutations of diploid cells of Saccharomyces cerevisiae induced by exposure to soft x rays. Results support the hypothesis that the elementary process of mutation is a fractional-colony mutation, probably corresponding to the single-strand change of DNA molecule of a gene, caused by the first hit of x rays and that an additional hit changes the fractional-colony mutation into a whole-colony one, which would correspond to double-strand change of DNA. (C.H.)

21921 ULTRAVIOLET IRRADIATION APPARATUS WITH GRATING MONOCHROMATOR. Takashi Ito (Rikkyo (St. Paul's) Univ., Tokyo). Idengaku Zasshi, 39: 151-4 (Sept. 1964).

An ultraviolet irradiation apparatus with a grating monochromator mounting is described that was designed to provide an action spectrum for genetic effects of ultraviolet light in yeast cells. (C.H.)

21922 VARIATION IN MUTAGENICITY AND RADIATION RESISTANCE WITH GENOME COMPLEXITY AND EVOLUTION. Sohei Kondo (Oak Ridge National Lab., Tenn. and National Inst. of Genetics, Misima, Japan). Idengaku Zasshi, 39: 176-98(Sept. 1964).

Data are summarized from studies on the radioinduced mutations in bacteria, fungi, viruses, insects, plants, and mice, and the apparent relation of DNA content to radiosensitivity. RBE for mutations is discussed and compared with RBE for somatic damages. It is pointed out that the apparent RBE for mutagenicity reflects not only the efficiency of premutation induction, but also that of the depression of repair mechanisms. Combining the above mentioned considerations with the results of other authors, it is concluded that there are mutagenic factors differing with genome complexity in addition to those common to all living things. The increase in resistance to radioinduced DNA damages with genome complexity is more remarkable for uv than for ^{32}P or x rays. Models based on the evolutionary standpoints are proposed for the origin of the uv resistance. Based on the evolutionary viewpoints, a repair-tolerance model is proposed for mutagenesis to account for the differential factors in mutagenesis mentioned; the differential factors are the reflection of the difference in the mechanisms of repairing and tolerating premutational DNA damages among different organisms. (87 references.) (C.H.)

21923 X IRRADIATION OF A SENSITIVE AND A RESISTANT STRAIN ESCHERICHIA COLI UNDER CONTROLLED OXYGEN CONCENTRATIONS. A. A. Van Soestbergen (Brookhaven National Lab., Upton, N. Y.). J. Bacteriol., 89: 1032-4(Apr. 1965).

Radiosensitive and radioresistant strains of Escherichia coli were given an x ray dose of 4,544 Rad at various controlled O_2 concentrations, and the results were subjected to probit analysis. An x^2 test gave no evidence of heterogeneity of departure from fitted parallel probit lines obtained after plotting the probit of the surviving fractions of each of the two strains on the logarithm of the O_2 concentration. Under the conditions of the experiment, the ratio of the oxygen concentrations at which equal fractions of populations of E. coli B/r and E. coli B-s were killed by x irradiation was estimated to be about 4.4. (auth)

21924 SUPPRESSION OF MITOSIS AND MACROMOLECULE SYNTHESIS IN ONION ROOTS BY HEAVY WATER. Arya K. Bal and Paul R. Gross (Brown Univ., Providence). J. Cell Biol., 23: 188-93(Oct. 1964).

The mitotic indices of onion roots (Allium cepa) fell precipitously after the addition of D_2O to the growth media, reaching zero at 12 hr. All cells remained arrested in interphase. No obvious alterations in the appearance of stained chromosomes were observed during the time that the mitotic index was declining, but the arrested interphase nuclei showed enlargement. (C.H.)

21925 RADIOSTERILIZATION VS. CHEMOSTERILIZATION IN HOUSE FLIES AND MOSQUITOES. C. H. Schmidt, D. A. Dame, and D. E. Weidhaas (Dept. of Agriculture, Gainesville, Fla.). J. Econ. Entomol., 57: 753-6(Oct. 1964).

A comparison was made of the effect of chemosterilants and ionizing radiation on the house fly and the common malaria mosquito in terms of the effectiveness of the resulting sterile males. Thus Musca domestica and Anopheles quadrimaculatus were sterilized by apholate or TEPA and by ^{60}Co radiation. For radiosterilization, house-fly pupae were treated 31 to 54 hr prior to enclosion with 2850 R and mosquito pupae >24 hr old with 10,000 or 12,000 R at 736 R/min. For chemosterilization, house-fly male adults 1 day old were fed 1% apholate in the diet for 3 days and mosquito male adults for 3 to 4 days after emergence. Mosquito male adults 0 to 24 hr old were also exposed to contact residues containing 7 mg/ft^2 of TEPA. All treatments, except radiation at 10,000 R produced complete sterility in most male mosquitoes. Under competitive conditions only the TEPA-treated males and males incompletely sterilized at 10,000 R performed as well as untreated males. These findings coincided with those from field studies in which TEPA-treated males appeared to be more aggressive than irradiated or apholate-fed males. The performance of the apholate-treated males and males irradiated at 12,000 R was similar: each showed about 26% reduction in mating vigor. Insemination rates of male mosquitoes exposed to TEPA or irradiated at 10,000 R varied little from those of males fed apholate or irradiated at 12,000 R. The most important criterion of effectiveness was the reduction in number of viable egg batches from females confined with both treated and untreated males. Results from chemosterilization equaled or surpassed those from radiosterilization. With mosquitoes, highly competitive, yet permanently sterile, males were more attainable with chemo- than with radiosterilization. With house flies, either method seemed adequate, but slightly greater recovery after irradiation than after chemosterilization was obtained. (BBB)

21926 SOME EFFECTS OF GAMMA RADIATION AND A CHEMOSTERILANT ON THE MEXICAN BEAN BEETLE. T. J. Henneberry, F. F. Smith, and W. L. McGovern (Department of Agriculture, Beltsville, Md.). J. Econ. Entomol., 57: 813-15(Dec. 1964).

The possible use of the sterile-male technique for the control of the Mexican bean beetle was investigated. The effect of ionizing radiation and a chemosterilant on the longevity and fertility of the Mexican bean beetle, Epilachna varivestis, was studied. Beetles of both sexes in different stages of development were exposed to ^{60}Co as a source of γ radiation at about 320 R/min. Fully fed larvae, 3-day-old pupae, or 2- to 3-day-old adults were exposed to doses of 1, 4, 8, or 16 kr. Other 2- to 3-day-old adult male or female beetles were dipped for 5 min in a 0.5% aqueous solution of apholate, or confined for 48 hr on lima bean foliage treated with apholate. Both radiation and this alkylating agent sterilized male and female beetles. With adults the effect was produced with radiation at 8 or 16 kR. Pupae were more susceptible: complete sterilization of females was obtained at doses of 1 to 16 kR and males were sterilized at doses of 4 to 16 kR. Larvae were more susceptible to direct radiation than pupae and pupae more susceptible than adults. Adult male or female bean beetles exposed to apholate were completely sterilized. Untreated female beetles mated with treated males (irradiated or exposed to apholate at effective doses) deposited about the same number of eggs as females of untreated pairs, but no eggs hatched. Treated female beetles (irradiated or exposed to apholate at effective doses) mated with untreated males deposited few or no eggs. Adult beetles of either sex irradiated in the pupal or adult stage or apholate-treated adults were shorter lived than untreated beetles. Untreated female beetles mated first with irradiated or apholate-treated males produced sterile eggs, but a subsequent mating with untreated males resulted in the production of viable eggs. (BBB)

21927 DIGITAL MALFORMATIONS IN THE MOUSE FETUS CAUSED BY X-RADIATION DURING PREGNANCY. Hiroshi Nogami (Nagoya Univ., Japan). J. Embryol. Exptl. Morphol., 12: 637-50(Dec. 1964).

Six groups of mice of the ddN strain were exposed to a single, whole-body x irradiation of 200 R on the different days between the 8th and the 13th day of pregnancy. Others were exposed to 150 R or 300 R on the 12th day of pregnancy. Mice of the CF_1 strain were also exposed to 200 R on the 12th day of pregnancy. Embryonic and fetal digits were examined both externally and microscopically 2, 6, 12, 18, 24, 48, and 72 hr after x radiation. After that they were examined at 1-day intervals until the 19th day of fetal age. The critical stage for digital malformations in the ddN mouse was in the beginning of the 12th day of embryonic stage. Digital rays with precartilage concentrations of the mesenchyme became obvious at this period. The incidence of digital malformations was proportional to the x-ray dose employed. Most malformations were of the reduction type, i.e., partial or complete ectrodactylism. The number of digits missing was proportional to the x-ray dose. The 2nd and the 3rd digits were most susceptible, while the 4th digit was most resistant. It was noticed that each malformation manifested itself also in various transitional forms. Differences between the ddN and the CF_1 strain in their tendency to manifest digital abnormalities were observed. Localized foci of cellular necrosis were already evident in the primordia of the digital bud 2 hr after x irradiation and the pyknotic nuclei were almost eliminated after 24 hr. The prospective pattern of malformations could already be detected externally before the cleft between the digits became marked. (auth)

21928 VERTEBRAL MALFORMATION IN THE MOUSE FETUS CAUSED BY X-RADIATION OF THE MOTHER DURING PREGNANCY. Ujihiro Murakami and Yoshiro Kameyama (Nagoya Univ., Japan). J. Embryol. Exptl. Morphol., 12: 841-50(Dec. 1964).

Mice of the ddN and CF_1 strains were exposed to a single dose of 200 R x radiation between the 8th and 13th day of pregnancy, and the fetal skeletons were examined on the 19th day of pregnancy. The phenomenon of a head-to-tail gradient shift in vertebral malformations as the stage of pregnancy at radiation advanced was less marked in the ddN strain, but in the CF_1 strain it was of similar proportions to that obtained by hypoxia. However, after x irradiation, malformations in the cervical and thoracic vertebrae presented two peaks of susceptibility. The first peak in malformation frequency may result from an effect of x radiation upon the early somite stage or it may be an indirect effect. The second peak may originate from a direct effect upon the primordium, i.e., upon the sclerotome itself. The incidence of cervical malformations was higher in the group treated on the 8th or 9th day, and in the group treated on the 11th day of pregnancy. The malformations presented such characteristics as enlarged rami of the posterior arch of the 1st cervical vertebra or, in the latter group, fusion of the cervical vertebra. There were also differences in the frequency of involvement of the vertebrae in these two strains which may be due to differences in the rate of differentiation of the vertebral primordium. Other differences were seen in the incidence of cervical ribs, of absence of the 13th rib, and of lumbar ribs. Such regional differentiation seems to be influenced by the genetic constitution. (auth)

21929 EFFECT OF METHOXYPSORALEN-INDUCED PHOTOSENSITIZATION UPON EPIDERMAL AND SERUM SULFHYDRYL. John M. Knox and Ryohei Ogura (Baylor Univ., Houston, Tex.). J. Invest. Dermatol., 42: 95-9(Jan. 1964).

Route of administration greatly influences the effects of methoxypsoralen after uv irradiation of rats. Topical application produces a high degree of uv photosensitivity, whereas oral administration produces only a moderate degree. Irradiation reactions are much more intense after intraperitoneal injection than after oral administration, yet considerably less severe than responses resulting from topical application. In unirradiated rats oral administration of the drug caused sulfhydryl values to rise above normal, whereas intraperitoneal injection decreased these values. However, neither route of administration altered epidermal sulfhydryl concentrations. Sulfhydryl concentrations in control and irradiated tissues varied greatly with the route of administration. The usual response to irradiation for both epidermal and serum sulfhydryl from control animals was a slight increase in values, but when methoxypsoralen was orally administered sulfhydryl decreased after irradiation. After intraperitoneal injection, the expected increase occurred. Adding methoxypsoralen to the serum did not effect sulfhydryl unless the serum was irradiated. Low concentrations produced the expected post irradiation rise in sulfhydryl values; yet high concentrations prevented the rise. Since oral administration produced effects on serum and epidermal sulfhydryl levels opposite to those of intraperitoneal injection, an intermediate compound may be responsible for the difference. A similar phenomenon may explain the differences between topical and oral psoralen photosensitivity. It is suggested that methoxypsoralen binds with protein during irradiation and that photosensitizer-protein compounds form as a result of the action of light. The irradiation effect on epidermal and serum sulfhydryl was not as pronounced with long-wave length uv light as with wide spectrum uv exposure. Also, in animals given injections of methoxypsoralen, serum sulfhydryl levels were increased after broad spectrum exposure, but not after long-wave length uv irradiation. Short-wavelength uv irradiation did not effect serum sulfhydryl. (BBB)

21930 THE EXPERIMENTAL PRODUCTION OF ELASTOSIS WITH ULTRAVIOLET LIGHT. W. Mitchell Sams, Jr., J. Graham Smith, Jr., and Peter G. Burk (Duke Univ., Durham, N. C.). J. Invest. Dermatol., 43: 467-71(Dec. 1964).

Since long-term exposure to sunlight results in dermal elastosis in the exposed skin, experimental production of elastosis in animals using artificial uv sources was attempted. Dublin ICR albino random-bred mice received 1.2×10^{10} erg/cm^2/day or 50 × the minimal erythema dose on untanned human skin from a Hanovia hot quartz lamp at a distance of 50 cm five times per week. The backs of other animals were painted with a 1% solution of croton oil in acetone twice weekly, and a third group received both croton oil and uv light. Another group received 20 times the minimal erythema dose on the untanned human skin four days per week 20 cm from a bank of four Westinghouse FS20 sunlampe, which have a continuous spectrum from 2900–3200 A. After one month of uv exposure, the ears had become reddened, thickened, and lost their fine texture. The dorsal skin of the animals also appeared thickened and friable. The animals developed marked edema and redness of the periorbital region and diffuse bilateral corneal opacities. Mortality rate approached 50%. Among the 100 mice, only five tumors, four squamous cell carcinomas, and one papilloma, were obtained; two of the squamous cell carcinomas were in the croton oil and uv group and the other tumors were in the hot quartz uv group. No tumors were produced in the last group. The epidermis of all experimental groups was acanthotic and the dermic thickened. Elastic fibers were considerably increased in number and size. The elastosis began around hair follicles, and it developed sooner in the croton oil and uv animals than after uv alone. It also developed faster in the animals receiving 2900–3200 Å uv than from a hot quartz lamp. Mucopolysaccharide showed increase in staining, particularly in papillary areas. Biochemical studies revealed no change in the neutral salt-soluble collagen but acetic acid-soluble collagen decreased as a function of radiation dose but particularly when the animals received both croton oil and uv. There was a striking decrease in the insoluble collagen in the uv-treated animals, but no significant difference in the elastin content of each group. It is concluded that elastosis, as determined histochemically, can be produced in albino mice with uv. Probably because of a dilutional phenomenon, biochemical studies were unable to confirm the histochemical demonstration of elastosis. (BBB)

21931 THE EFFECT OF RADIOPHOSPHORUS DECAY ON CISTRON FUNCTION IN BACTERIOPHAGE T4. I. LONG-RANGE AND SHORT-RANGE HITS. Philip D. Harriman and Gunther S. Stent (Univ. of California, Berkeley). J. Mol. Biol., 10: 488-507(Dec. 1964).

The effect of disintegration of incorporated ^{32}P atoms on the functional survival of different viral cistrons was investigated by infecting nonpermissive host bacteria jointly with a nonradioactive rII or am T4 mutant and with highly ^{32}P-labeled T4 am$^+$ wild-type phage, and then following upon radioactive decay the loss of ability of the wild type to complement growth of the conditionally lethal mutant phage in the same cell. These experiments showed that the function of each of eleven different viral cistrons is abolished by ^{32}P decay at about half the rate of loss of viability of the whole phage. The relative ^{32}P decay sensitivity of one-half cannot represent the functional inactivation of about half of the viral genome by each lethal ^{32}P disintegration, since the ability of the wild-type phage to complement a variety of am double mutants is lost only slightly faster than, and never at twice, the rate of loss of complementation of single am mutants. Nevertheless, the sensitivity of multiple cistron function does increase as more and more am mutant cistrons are brought into play, until in the case of complementation of a sextuple am mutant, joint functional survival of six cistrons is lost at 0.8 the rate of loss of viability of the whole am$^+$ phage. These observations can be interpreted by postulating two types of lethal ^{32}P disintegrations, long-range hits that cause functional inactivation of the whole, and short-range hits that inactivate only part of the viral genome. Analysis of the results from this point of view shows that about half of the lethal ^{32}P hits are of the short-range type if decay proceeds either at –196°C or at +4°C. The frequency of short-range hits is sharply reduced; however, if the free radical trap AET is present during decay at 4°C, suggesting that short-range hits represent radiochemical lesions, in the production of which free radicals play an important part. Calculation of the fraction of all ^{32}P disintegrations that inactivates a given cistron by short-range hits shows that this function is equal to about half the total share of the whole genome represented by that cistron. This coincidence leads to the notion that half the ^{32}P disintegrations occurring within the confines of a viral cistron produce sublethal damage preventing its functional expression, unless the damage had first been erased by a repair process which can proceed in the infected cell. Short-range hits would then correspond to lesions in the viral DNA that render nonerasable, and thus permanently fix, all sublethal cistron damages that have already occurred, or may yet occur, upon further decay. (auth)

21932 EARLY HISTOCHEMICAL CHANGES IN IRRADIATED SALIVARY GLANDS AND LYMPH NODES OF THE RAT. J. S. Greenspan (Royal Dental Hospital, London). J. Pathol. Bacteriol., 88: 439-52(Oct. 1964).

The basic mechanism by which radiation produces cell injury may involve the disruption of intracellular enzyme systems. Since cell damage from radiation is focal rather than uniform, histochemical techniques are particularly suited for further exploring this possibility. Thus these techniques were used to compare changes produced by radiation in a sensitive tissue with those occurring in relatively resistant tissues. Male adult rats were locally irradiated with 2000- or 4000-rad doses of x rays. Histochem-

ical and histological changes were comparable in the two groups of irradiated animals, but alterations were generally more marked and appeared sooner after 4000 rad. In lymph nodes the earliest morphological changes were seen at 1½ hr following 4000 rad, with nuclear fragmentation of lymphocytes and lymphoblasts. Cellular necrosis became more obvious at 4 and 8 hr, and by 24 hr the follicle pattern was lost and there was histiocytic phagocytosis of the nuclear debris. The earliest histochemical change was a general increase in enzyme activity in histiocytes, first those within and about follicles, and then elsewhere in the pulp. Most notable was an increase in aminopeptidase, which was striking at 4 hr and possibly present as early as 30 min. Also increased at 4 hr were esterase, cytochrome oxidase, monoamine oxidase, and dehydrogenases. Similar increases were also seen in lipids, sulfhydryl groups, and PAS-positive material. The increases in histiocytes were transient; they reached a peak at about 8 hr and had diminished or disappeared by 1 to 2 days. The follicles themselves showed increased acid phosphatase only. Of the salivary glands studied, the parotid was the most radiosensitive, and the earliest histological changes were seen at 24 hr after 4000 rad as focal acinar cell necrosis with karyorrhexis and marked cytoplasmic eosinophilia. The earliest histochemical change occurred before the first histological evidence of injury; most striking was loss of acid phosphatase from parotid acini at 8 hr. Aminopeptidase showed slight increases in ducts at 24 hr. As in the lymph nodes, the only late enzyme change was in alkaline phosphatase. In sublingual gland morphological changes were slight. Only at 22 days after 4000 rad was there interacinar separation, possibly due to edema. There was, however, infiltration of mast cells throughout the sublingual gland, appearing at 13 days. The most obvious histochemical change was a focal increase in acid phosphatase in scattered acinar cells, first at 2 days after 4000 rad. No histological changes were seen in the submandibular gland. The most notable histochemical change was a rapid decrease in the normally high aminopeptidase activity of intercalated ducts at one day after 4000 rad. In accord with the hypothesis that the disruption of intracellular enzyme systems initiates cell damage after irradiation, histochemical changes were noted before visible histological damage. That aminopeptidase and acid phosphatase were selectively affected in different tissues suggests a common underlying mechanism. Some hydrolytic enzymes, including acid phosphatase, are confined within intracellular organelles (lysosomes), and release of these enzymes is effected by damage to the phospholipid membrane that confines them. Radiation could disrupt these phospholipid membranes, releasing hydrolytic enzymes, and this may be the mechanism that produces the early enzyme changes observed. There was no alteration in other enzymes prior to morphological damage to suggest early mitochondrial disruption. Alkaline phosphatase activity increases in lymph nodes and parotid may be a reflection of increased metabolic activity with repair as of direct but delayed radiation damage. (BBB)

21933 SUPEROVULATION FOLLOWING OVARIAN X-IRRADIATION. Anita M. Mandl (Univ. of Birmingham, Eng.). J. Reprod. Fertility, 8: 375-96(Dec. 1964).

Ovarian irradiation has often been used clinically in sterile women to induce ovulation, but no controlled studies have demonstrated the effectiveness of this treatment. These experiments were undertaken in order to discover whether unilateral irradiation with doses of less than 600 R is followed by superovulation in the contralateral ovary; the extent to which the effect is specific for radiation-induced changes in one ovary; and whether superovulation is mediated by growth of excessive numbers of follicles or the rupture of some which would normally degenerate at advanced stages of development. Direct x irradiation of one ovary of rats with 315 or 630 R was followed by a reduction in the number of eggs shed on the irradiated side, and compensatory overactivity by the unirradiated ovary. Unilateral irradiation with 157 R, or exposure of one ovary to air (involving surgical handling) induced slight superovulation on the treated side. The total number of eggs shed by both ovaries was highest in unilaterally irradiated animals whose second ovary was exposed to air; slightly fewer eggs were shed by those whose second ovary was left untouched; and the least number was recorded for control animals one of whose ovaries was exposed to air (the other left untouched). The degree of superovulation was less pronounced than that for rats irradiated bilaterally with 157 R. The results suggest that the superovulatory effect of irradiation is primarily due to nonspecific damage to the ovary, and is mediated by a reduction in the number of pre-existing large Graafian follicles undergoing atresia. Newly formed corpora lutea in unilaterally irradiated ovaries were consistently smaller than those in nonirradiated ovaries. The effect is apparently due to radiation-induced damage sustained by the granulosa cells before ovulation. In animals irradiated at metestrus and which mated the following estrus, the number of unfertilized eggs was higher on the irradiated than on the unirradiated side. Even so, the proportion of unfertilized eggs on the unirradiated side was higher than in normal animals. The proportion of tubal eggs showing morphological abnormalities was very low. By the time of autopsy, 9 to 10 hr after expected ovulation, pronuclear development had not proceeded as far in unilaterally irradiated as in unirradiated animals. The effect was particularly marked on the unirradiated side. Unilateral irradiation appears to disturb the developmental synchronization of oocytes between the two ovaries, and may induce the premature rupture of a small number of follicles. (BBB)

21934 RADIOSENSITIVITY AND GENETIC COMPLEXITY. Mario Terzi (International Lab. of Genetics and Biophysics, Naples). J. Theoret. Biol., 8: 233-43 (Mar. 1965).

There is a strong correlation between the DNA content and the mean lethal dose in unicellular organisms. The constant of this inverse proportionality assumes four discrete values according to the genetic complexity of the organisms. The first level of radiosensitivity is that of viruses containing RNA or single-stranded DNA, the second is that of viruses containing double-stranded DNA, the third corresponds to bacteria and haploid fungi, the last to polyploid yeast cells and diploid cells from vertebrates including man. A tentative explanation of the four levels and of the radiation inactivation mechanism is given. (auth)

21935 ON THE RELATION BETWEEN DOSE AND RADIATION EFFECT IN THE CASE OF UNHOMOGENEOUS DOSE DISTRIBUTION. Th. Gruenewald (Bundesforschungsanstalt fur Lebensmittelfrischhaltung, Karlsruhe, Ger.). Kerntechnik, 7: 117-18(Mar. 1965). (In German).

A comparison of the effects of different kinds of ionizing radiation on biological systems demands an equal dose and an equal dose rate. It can be shown that in the case where no linear connection exists between dose or dose rate and realized effect of irradiation, an equal dose distribution is necessary, too. Such a non-linear connection makes possible an estimation of the inhomogeneity of the dose distribution, i.e., of the deviation of the dose from the mean value at special arrangements for irradiation. (auth)

21936 REACTION OF THE IRRADIATED ORGANISM TO CRITICAL ACCELERATIONS. B. I. Davydov, V. V. Antipov, and P. P. Saksonov. Kosmich. Issled., 3: 159-66 (Jan.-Feb. 1965). (In Russian)

A study was made of the effects of radiation on the ability of male mice to withstand critical magnitudes of acceleration. In all, 1400 animals were studied. In evaluating the viability of animals exposed to acceleration, their condition was determined after exposure. The purpose of using an extremely high acceleration was to reveal those subtle and unstable compensatory mechanisms which are not ordinarily apparent. Animals were irradiated in an RUM-11 device in doses of 250, 500, 700, and 850 R (13 R/min) and then exposed to accelerations of 40–42 g for 3 min in a back-to-chest position. The radius of the centrifuge was 0.31 m. At these accelerations, approximately 50%

of the control animals died. Any trend which differed from this figure was used as an index of changes in stability on the part of the irradiated animals. It was concluded that mice became more tolerant of acceleration 1–7 days after exposure to 250, 500, and 700 R. There is a relationship between the irradiation dose and the acceleration tolerance. Control animals exposed to preliminary centrifugation showed increased resistance to repeated accelerations which was not observed in animals irradiated with 760 R on the first day after exposure. (ATD)

21937 DIAGNOSTIC IMPLICATIONS OF RETICULOENDOTHELIAL PHAGOCYTIC ACTIVITY. J. Neill Kennedy and William McFarland (Veterans Administration Hospital, Washington, D. C.). Med. Ann. District Columbia, 33: 557-60(Nov. 1964).

A case of Thorotrast retention is described, along with three other cases (abnormal Fe storage, anthracosilicosis, lipoid pneumonia) illustrating the use of phagocytosis by reticuloendothelial (RE) cells as an aid in diagnosis. Clinically the phagocytic function of the RE system can be assessed in several ways. Earlier techniques with the use of carbon, Thorotrast, radioactive chromic phosphate, colloidal gold, and colloidal silver are given. These were not satisfactory, since these substances are not metabolized and remain indefinitely in the RE system. Recently the use of ^{131}I-labeled aggregated albumin was introduced as a technique to measure the phagocytic function in the RE system. The ^{131}I-tagged albumin is metabolized, and the ^{131}I label can be measured in the blood and is eventually eliminated in the urine. In the Thorotrast retention case a 57-yr-old man was evaluated for pancytopenia. In 1943 he had received two doses of an unknown quantity of Thorotrast in the left carotid artery for a cerebral arteriogram to evaluate a bruit below the left ear. The x-ray studies were normal. In 1950 a medical examination including a hemogram was normal. Bone-marrow examination was performed. The marrow was hypocellular but showed a normal maturation index. A greenish-gray material identified as ThO_2 was observed scattered throughout the bone marrow. Thorotrast injected intravenously is rapidly filtered out of the blood stream by macrophages in the liver, spleen, and bone marrow. This rapid phagocytosis of Thorotrast, especially in the liver and spleen, produces radiologic contrast in these organs and was used to evaluate them anatomically and functionally. Thorotrast, however, is not metabolized and therefore remains indefinitely in the organ that removed it from the circulation. The long-term effects of this agent include leukemia and primary malignant tumors of the liver, lung, and at the site of injection. There has been a previous case report of aplastic anemia occurring 14 yr after the injection of Thorotrast, and the pancytopenia in the present patient may have been the result of the constant radiation emitted by the Thorotrast in bone marrow. The examples cited here suggest that, because of the unique phagocytic function of the RE system, the search for foreign pigments and other substances in the bone marrow can be particularly useful in suspected pneumoconioses, lipoid pneumonia, and Thorotrast retention. (BBB)

21938 CHANGES OCCURRING IN THE SECRETORY AND INCRETORY FUNCTION OF THE PANCREAS IN ACUTE RADIATION SICKNESS. A. K. Ezhov. Med. Radiol., 10: No. 3, 49-57(Mar. 1965). (In Russian)

Experiments were conducted on 4 dogs. Tests included 2 types of food stimulants: strong–consisting of meat and weak–of milk. Subject to estimation in the pancreatic juice were the following enzymes: trypsin, lipase, and amylase. The function of the insular system was looked into by the method of sugar curves with a double glucose loading. Three dogs received 300 R of x rays, while the fourth was submitted to irradiation with a dose of 350 R. With the developing radiation injury the animals began to demonstrate excretory disturbances of the pancreas, which were related to the severity of the pathological process, the stage of radiation sickness, and the type of the food stimulus used. In tests with meat the presence of sharp undulating hyposecretory derangements in the amounts of the juice and enzymes could be noted. In experiments to milk stimulus, hypersecretion, however, devoid of any marked undulating characteristics, was observed. As compared to secretion the reduced incretory function of the pancreas set in at a later date. With subacute evolution of the radiation lesion one dog showed these changes to occur periodically. It was concluded that the nature of the results are associated with parabiotic condition of the neuro-secretory apparatus, which develops along with the evolution of the radiation injury. (auth)

21939 CONSIDERATIONS ON SEVERAL CASES OF RADIODERMATITIS FOLLOWING DIAGNOSTIC EXAMINATIONS. F. Albertazzi, G. Lovera, and M. Visetti (Universita, Turin). Minerva Dermatol., 36: 86-93(Mar. 1961). (In Italian)

This study concerns three patients with radiodermatitis resulting from diagnostic fluoroscopic x-ray procedures. The respective patients were fluoroscoped for periods of 40 min, 90 min including interruptions, and the third patient was fluoroscoped for a long undetermined period. At subsequent intervals of six months, four months, and fifty days, radiodermatitis lesions were observed. The lesions appeared as brownish, pigmented, erythematous, and opalescent, with teleangiectasis, central granulation, and eczematoid exudative ulceration. Two patients were first treated unsuccessfully with silver nitrate, and later with estrogen and cortisone, and finally plastic surgery with autografts. The third patient responded to topical silver nitrate treatment. The diagnostic procedures involved fluoroscopy for extracting a metal fragment, duodenal exploration, and nephrolithiasis. One patient showed a residual lesion which was hyperpigmented at its margins. All lesions were observed in the focal area of the radiation. Effects of x-ray kilovoltage on depth of tissue injury are discussed. With 10-kv x rays, 80% of the ionizing radiation is absorbed in the first mm of skin depth, dispersing most of its energy in the epidermis. With 30-kv x rays and a 0.3-mm Al filter, 50% of the ionizing energy is absorbed to a depth of four mm. With 50 kv and a filter of one-mm thickness the dispersion rate is 50% and depth absorption is eight mm. At 80 kv with a one-mm filter, absorption is 50%, depth two cm; 100 kv with three-mm filter, 50% absorption at a depth of four cm, and with 0.25 mm Cu filter, absorption to a depth of six cm. The focus-skin distance was 30 cm for these calculations. Today, 60- to 70-kv x rays are frequently used in fluoroscopy and can be considered likely to produce skin damage. For radiodiagnostic purposes, it is advisable to use harder and more filtered x rays, all intensities above 90 kv being considered hard. For diagnostic and portable x-ray machines, the use of adequate filtration is recommended, as well as harder x rays, efficient diaphragms and cones, and an accurate timer to limit the duration of fluoroscopy. Finally, it is noted that in none of the cases reported here was the examination performed by a trained radiologist, and it is pointed out that all stationary and portable fluoroscopic x-ray machines can become extremely dangerous when used by inexperienced personnel because of the prolonged low intensity irradiation which may be hazardous to the patient as well as his offspring. (BBB)

21940 EFFECT OF X-IRRADIATION ON CHANGES OF CELL DISTRIBUTION CURVE OF MOUSE BONE MARROW AS DETECTED BY ELECTRONIC PARTICLE COUNTING. Hun Lee and Victor Richards (Presbyterian Medical Center, San Francisco). Nature, 205: 820-1(Feb. 20, 1965).

With the aid of the Coulter blood counter, examinations were made on the cell-size distribution of mouse femoral marrow from non-irradiated normal animals and the cell distribution changes in the marrow of irradiated animals. LAF_1 male mice of 10-12 weeks of age were exposed to a whole-body x irradiation ranging from 10 to 800 R (LD_{100}). The animals were killed by an overdose of ether 24 hr following irradiation. The cells' percentages were plotted against threshold units to form a cell distribution curve. A comparison of the curves revealed that curves from animals exposed to the following radiation doses, 800, 600,

400, 200, and 100 R, differed from the standard curve of the non-irradiated animals in the 10-15 unit range; they had a much higher percentage of cells than that of the non-irradiated animals, and in the 30-70 unit range of the curve, the 30-70 unit section of the curve is shaped like a hump in all the non-irradiated marrow. Below 100 R exposure the cell distribution curves, including the 10-15 unit section and the hump, were similar to the curves of non-irradiated marrow. This suggests that the response may be an all-or-none phenomenon with a threshold somewhere around 100 R. It is believed that distribution changes are not due to changes in cell-size, but to changes in conductivity of the cell caused by cell membrane injury from irradiation, and that changes in conductivity of the cell are triggered off by a critical radiation dose. (P.C.H.)

21941 PROTEASES AND THE DEPLETION AND RESTORATION OF SKIN RESPONSIVENESS TO RADIATION. B. Jolles and R. G. Harrison (General Hospital, Northampton, Eng.). Nature, 205: 290-1(Feb. 27, 1965).

Studies were made on the role of enzymes in the depletion and restoration of skin responsiveness to radiation. While it is accepted that the very early changes in vascular permeability are mediated by histamine, the delayed response is independent of the histamine effect. Results showed that soya bean trypsin inhibitor has an effect similar to that of whole-body irradiation. The results also indicate that enzymatic processes are involved in the described phenomena of reduction or abolition and restoration of tissue responsiveness. This was confirmed in a series of experiments by the use of amino-n-caproic acid as the proteolytic agent. The action of this amino acid in diminishing the capillary permeability supports the suggestion that this phase of inflammation is initiated by a protease system liberating proteolytic portions pharmacologically active on capillary endothelium. (P.C.H.)

21942 PSYCHIATRIC WARD BEHAVIOR AND GEOPHYSICAL PARAMETERS. Howard Friedman (Veterans Administration Hospital, Syracuse, N. Y. and State Univ. of New York Upstate Medical Center), Robert O. Becker, and Charles H. Bachman. Nature, 205: 1050-2(Mar. 13, 1965).

An investigation was made of the relation between the behavior of selected psychiatric patients and geophysical parameters. The behavior of the patients was evaluated daily by ward nurses using a 10-item, 4-point evaluation scale. The 12 male patients were diagnosed as schizophrenic with sub-types ranging from paranoid, catatonic, and simple, to undifferentiated. Daily data on natural geomagnetic field intensity, cosmic ray activity, daily total neutron counts, and daily cosmic ray indexes were obtained from U. S. and Canadian government sources. Pearson product-moment correlation coefficients were computed between the daily measures of the geophysical parameters and each patient's behavior rating for the same day and the two subsequent days. A statistical analysis of the data showed no significant relation between total range of geomagnetic activity as measured conventionally and parameters of human psychological disturbances. Cosmic ray indexes appeared to relate significantly to both gross and crude measures of human disturbance, such as psychiatric hospital admissions and individual ratings of ward behavior. (C.H.)

21943 DISSOCIATION OF SKIN HOMOGRAFT TOLERANCE AND DONOR TYPE GAMMA GLOBULIN SYNTHESIS IN ALLOGENEIC MOUSE RADIATION CHIMAERAS. Noel L. Warner (Stanford Univ., Palo Alto, Calif.), Leonard A. Herzenberg, Leonard J. Cole, and William E. Davis, Jr. Nature, 205: 1077-9(Mar. 13, 1965).

Donor-type γ-globulins were found in allogenic mouse radiation chimeras without tolerance to skin homografts from donors of the same strain. Results are reported from studies on dissociation of tolerance in 5 groups of allogenic chimeras set up under varying conditions in a deliberate attempt to compare the induction of tolerance to skin homografts with the concomitant presence of donor-type γ-globulin. (C.H.)

21944 EFFECT OF IONIZING RADIATION ON RESPIRATION AND ETHYLENE PRODUCTION OF AVOCADO FRUIT. Roy E. Young (Univ. of California, Los Angeles). Nature, 205: 1113-14(Mar. 13, 1965).

Results are reported from studies on the effect of γ-radiation on respiration and ethylene production by avocado fruit. The data show that ethylene synthesis and enhanced respiration can be induced in preclimacteric avocado fruit by 10 kRads of γ radiation given at the rate of 100 Rads/min. However, once normal ethylene synthesis and enhanced respiration were initiated, no effect of radiation could be perceived. It was concluded that either γ radiation or normal metabolic changes associated with ripening can induce ethylene synthesis in avocado fruit by a process involving similar steps. (C.H.)

21945 RESPONSES OF VARIOUS STRAINS OF ESCHERICHIA COLI TO INHIBITION OF SOME BIOSYNTHETIC PROCESSES AFTER ULTRA-VIOLET IRRADIATION. E. Kos, M. Drakulic, and B. Brdar (Inst. "Ruder Boskovic," Zagreb). Nature, 205: 1125-6(Mar. 13, 1965).

The effects of incubation in a liquid mineral medium supplemented with the essential metabolite on the recovery of 3 deficient strains of Escherichia coli from the lethal effects of ultraviolet radiation were investigated. Colony-forming ability of control and irradiated samples up to 120 min post-irradiation was compared. A significant recovery of the uracil-less strain was obtained in the presence of uracil and recovery was evident with the tryptophan-less strain when grown in the presence of tryptophan, but the lack of the essential amino acid provoked a rapid decrease in the survival of the methionine-less strain. It was concluded that inhibition of protein biosynthesis following ultraviolet irradiation may lead to the restoration of some bacterial strains but to a decrease in viability of others. (C.H.)

21946 UNUSUAL REACTION OF SWEET CLOVER SEEDS TO X-RADIATION AT DIFFERENT MOISTURE CONTENTS AND TO POST-IRRADIATION STORAGE. Alexander Micke (Universitat, Gottingen, Ger.). Nature, 205: 1126(Mar. 13, 1965).

Results are reported from experiments performed to test the influence of seed moisture and post-irradiation storage environment on radiation damage of sweet clover (melilatus albus) and barley seeds. Results indicated one factor causing increased damage and one factor leading to recovery acting alternately during the storage period. Storage in air after exposure to x radiation was strongly influenced by the relative humidity in the air. (C.H.)

21947 DEPENDENCE OF DNA SYNTHESIS ON IRRADIATION DOSE RATE. W. B. Looney (Univ. of Virginia, Charlottesville). Nature, 205: 1334-6(Mar. 27, 1965).

The relation of radiation dose-rate depression of DNA synthesis was investigated. Lewis strain rats (200 g) were given a total dose of 300, 50, 25, and 12.5 R/min. The experiments were designed so that all periods of radiation, with variations in dose rate, ended at 19 hr after partial hepatectomy. The fractionated dose rate experiments were: 500 R at 17, 18, and 19 hr after partial hepatectomy, and 750 R at 17 and 19 hr after partial hepatectomy. The results showed that the 1500 R total dose given at the rate of 300 R/min, reduced the rate of DNA synthesis to approximately two-thirds of the control values. There was a consistent depression of the rate of DNA synthesis with the lowering of dose rate and the increasing time of radiation. This became significant at the 0.05% level when the rate of 12.5 R/min was reached. The results from fractionated doses suggests that effects, if any, on the formation of new biological units are of short duration, since the depression of DNA synthesis is essentially the same, whether the dose is given in 5 min, or given in divided doses over a 60- or 120-min period. (P.C.H.)

21948 MODIFICATION OF X-RAY SURVIVAL CURVES OF STEM-CELLS BY DIFFERENT DOSES OF ERYTHROPOIETIN. D. D. Porteous, S. C. Tso, K. Hirashima, and L. G. Lajtha (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature, 206: 204-6(Apr. 10, 1965).

Polycythemic mice were exposed to doses of x radiation ranging from 50 to 300 Rads and erythropoietin was injected immediately at 2 dose levels, followed 52 hr later by ^{59}Fe administered as citrate. Three days later blood samples were analyzed for radioactivity. A 10-fold increase in the dose of erythropoietin gave an approximately 2-fold increase in ^{59}Fe incorporation in sham-irradiated controls, but a greater increase was seen in the irradiated animals. A lower dose of erythropoietin resulted in a less-marked increase in ^{59}Fe incorporation. Possible explanations are presented for the apparent difference of radiation effect when different doses of erythropoietin were given. (C.H.)

21949 REDOX EQUILIBRIUM IN VIVO AFTER WHOLE-BODY IRRADIATION. C. Streffer and H.-J. Melching (Universitat, Freiburg I. B.). Naturwissenschaften, 52: 59-60 (1965). (In German)

The content of the metabolite pair lactate–pyruvate and β-hydroxybutyrate–acetoacetate was investigated in the liver of white mice after exposure to 690 R. The results are tabulated and show that the lactate concentration increases significantly 1½ and 3 hrs after the irradiation. An increase of the pyruvate concentration was also noticed. The ratio lactate/pyruvate is significantly decreased. The concentration of β-hydroxybutyrate decreases, but only after 12 hrs is there significant decrease in the acetoacetate concentration. The β-hydroxybutyrate/acetoacetate also decreases. (J.S.R.)

21950 SULFONAMIDE EFFECT AND RADIATION SENSITIVITY. Andrei Lazanyi (Centrul de Cercetari Biologice, Cluj). Naturwissenschaften, 52: 60(1965). (In German)

The combined effect of sulfonamide treatment and x or γ irradiation on chromosone aberrations were investigated in Vicia faba. The radiation damage was evaluated by determination of the aberration frequency in the anaphase and of the inhabitation of the auxiliary root growth. The results show that the relative fraction of the radioinduced anaphase breaks in the presence of sulfaguanidine increased. Results for sulfamethacine were also reported with similar but slighter effects. The mechanism responsible is discussed. (J.S.R.)

21951 EFFECTS OF X-RAY IRRADIATION ON SECONDARY GILL FORMATION AND TAIL REGENERATION OF BRANCHIURA SOWERBYI. PART I. Norimoto Tanaka (Kyoto Prefectural Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1314-25(Feb. 1964). (In Japanese)

The x irradiation of the secondary gill formation and tail regeneration of Branchiura sowerbyi was studied. The tail of non-irradiated Branchiura sowerbyi was regenerated 5–7 days after amputation and the secondary gill was formed at the near trunk of amputation during tail regeneration. The secondary gill formation was not affected by the irradiation up to 150 kR. If the tail amputation was done immediately after the irradiation, the tail regenerations for doses of 3 and 4.2 kR were 100 and 80%, respectively; but the tail did not regenerate at a dose of 5 kR or more. The tail regeneration for a dose of 3 kR was 100% but the regeneration time was longer than that of the non-irradiated; the delay in the tail regeneration showed a tendency to recover if the amputation was done 4 days or more after the irradiation. Tail regeneration was observed for doses of 3 and 6 kR, when the first amputation was done immediately after the irradiation and the second was done 14 days after; the tail did not regenerate for doses of 9 and 12 kR. The recovery of the tail regeneration for a dose of 6 kR or less was a result of reversible damage. (NSA of Japan)

21952 STUDIES ON PREOPERATIVE AND POST-OPERATIVE TELECOBALT THERAPY IN GASTRIC CANCER. REPORT XVI. Tatuo Takahashi (Yuri Kumiai General Hospital, Akita, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 897-902(Oct. 1964). (In Japanese)

Patients treated for stomach cancer were divided into 4 groups: (I) those who had a dose of 200 or 300 R through the anterior or posterior venter wall from 1 or 2 ports (controls group), (II) those who had a dose of 200 R through the anterior venter wall from 1 port, (III) those who had a dose of 200 R through the anterior and posterior venter walls from 2 ports, and (IV) those who had a dose of 300 R through the anterior and posterior venter wall from 1 or two ports. The subjective and objective symptoms of these groups were compared when they had a dose of 4000 R upon the foci. It was found that Group IV had the poorest appetite, Group III had a comparatively poor appetite, and Group IV had comparatively the best appetite. The same gradual decrease was found in regard to the severity of nausea, vomiting and total enervation. Decrease in body weight was most marked in Group (IV) followed by Group II, while Group II had a tendency toward increase. (auth)

21953 STUDIES ON PREOPERATIVE AND POST-OPERATIVE TELECOBALT THERAPY IN GASTRIC CANCER. REPORT XVII. Tatuo Takahashi (Yuri Kumiai General Hospital, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 903-9(Oct. 1964). (In Japanese)

Patients treated for stomach cancer were divided into 4 groups: (I) those who had a dose of 200 or 300 R through the anterior or posterior venter wall from 1 or 2 ports (controls group), (II) those who had a dose of 200 R through the anterior venter wall from 1 port, (III) those who had a dose of 200 R through the anterior and posterior venter walls from 2 ports, and (IV) those who had a dose of 300 R through the anterior and posterior venter wall from 1 port. The subjective and objective symptoms of these groups were compared when they had a dose of 400 R upon foci. The decrease in the quantity of red cell and hemoglobin was most marked in Group I followed by Group III and Group IV, which had about the same degree of decrease. The decrease in the quantity of leukocytes was most marked in Group II followed by Group III and Group IV, which had about the same degree of decrease. There was little difference in decrease in blood platelets among the three groups, and no definite tendency was observed. Acceleration of red cell sedimentation rate was greatest in Group IV, followed by Group II, and in Group III it was retarded. Group IV had the severest hepatic dysfunction, followed by Group II, and Group III was the least severe. (auth)

21954 RADIATION EFFECT ON INTESTINAL FUNCTION. II. COMPARATIVE STUDY OF SPECIES DIFFERENCE IN RADIATION EFFECT ON INTESTINE. Osamu Matsuoka and Takehiko Tsuchiya (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 910-15(Oct. 1964). (In Japanese)

Four species of experimental animals, mouse, rat, guinea-pig, and rabbit were employed for comparative study of intestinal effects of radiation. Two types of purgatives of different action mechanism such as an anticholinesterase drug and $MgSO_4$ were given to these species. Anti-ChE drug, Fisostigmine methyl sulfate, did not produce diarrhea in mice, rats, and guinea pigs but did in rabbits. $MgSO_4$ produced diarrhea in mice and rats, but not in guinea pigs and rabbits. As the radiation induces diarrhea in the animals which are susceptible to its induction by $MgSO_4$ but not by anti-ChE drug, it is suggested that there is a close relationship between water absorption mechanism from the intestine and the radiation induction of diarrhea. Intestinal length of five strains of mouse, and rat, guinea pig and rabbit were measured in three intestinal components, i.e., small intestine, caecum and large intestine. The proportion of these components was calculated in each strain and species. There was no strain difference in mice, but there was remarkable difference among species. The order in the proportional length of caecum in these species agreed with that of their radiotolerance. It was suggested that species that have a large caecum are resistant to radioinduced intestinal damage. In order to establish this hypothesis, experimental caecumtomy of rabbit intestine was tried. Four whole-caecumtomized and one appendectomized rabbit were exposed to 1500 R of x rays in the abdominal region. The caecumtomized animals developed heavy diarrhea several days after irradiation resulting in in-

testinal death in 4–11 days, but the appendectomized one did not develop diarrhea and survived 21 days. It is concluded that the morphological character of the intestine plays a modifying role in the development of intestinal damage caused by radiation. (auth)

21955 RADIOSENSITIVITY OF THE HETEROGENEOUS MICE GROUP OBTAINED FROM THE CROSSES BETWEEN RADIOSENSITIVE AND RADIORESISTANT INBRED STRAINS OF MICE. Junzo Yamada and Jun-ichiro Hayakawa (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 930-4(Oct. 1964). (In Japanese)

A heterogeneous mouse group was obtained from crosses between radiosensitive inbred mice (strains CF #1 and RF) and a radioresistant strain (C57BL/6) in order to study the difference of radiosensitivity between the albino and colored progenies within this group. When irradiated by 650 R of x rays, the heterogeneous mouse group appeared to be more resistant than the mice of C57BL strain. From the comparison of the mortality of the albino and colored progenies within the heterogeneous group, it was found that there was no statistically significant difference between them. Another observation concerned with the testis weight loss for a week after x irradiation at the various doses (400–900 R) was performed with the same group. The differences between the albino and colored progenies were not significant in the following items: (1) testis weight loss in each dose, (2) regression coefficients of testis weight loss on dose, (3) values of LD_{50}, and (4) survival days in each dose. There was, however, some indication in each of the above items that the albino progeny was slightly radiosensitive by comparison with the colored one, in spite of no statistical difference. These results might suggest that the albino gene has some influence in the expression of radiosensitivity under the condition of uniform genetic background, but that the influence may not be intensive. (auth)

21956 EFFECT OF RADIATION ON THE NAIL TISSUE. Kazuhisa Haruyama (Tokyo Medical and Dental Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 1113-32(Jan. 1965). (In Japanese)

Toe nails of the hind legs of rats were irradiated by x radiation and effects were studied by micro- and macroscopic observation. Nail matrix is most radiosensitive and next is nail bed tissue. As for matrix, the proximal portion is more sensitive than the distal part. By single irradiation, 1000 R shows almost no changes, 2000 R gives severe injuries with later recovery, and 3000 R, more severe damage but no recovery. Radiation effects were reduced by fractionation of dose. Shedding (fall off) of nail after irradiation was observed earlier as dose increases. Mechanisms of shedding of nail were discussed. Recovery index of nail tissue, shedding taken as an indicator, was almost equal to that of the skin. Growth rate of nail tissue is about 0.1 mm per day for man and 0.15 mm per day for rat, and growth rate was prolonged by irradiation. Processes of restoration after pulling out of nail were studied histologically. As a whole, radiosensitivity of nail tissue was shown less than that of skin and hair. (NSA of Japan)

21957 INFLUENCE OF TIME FACTOR ON BIOLOGICAL EFFECTS OF X-IRRADIATION ON MICE BEARING SOLID TYPE EHRLICH'S CARCINOMA. PART I. EFFECT OF IRRADIATION INTERVALS ON SURVIVAL RATE. Keichiro Ogino (Okayama Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 1133-40(Jan. 1965). (In Japanese)

Solid-type Ehrlich's carcinomas inoculated into the right legs of Cb mice were treated with x rays at three different fractionations consisting of irradiation at intervals of seventy-two hours, involving 3 × 500 R daily and 7 × 500 R every three days to 5,000 R in 24 days; irradiation at intervals of twenty-four hours, involving 10 × 500 R daily to 5000 R in 10 days; and distributed daily irradiation, involving 3 × 500 R daily and 21 × 500 R 3 times every day to 5000 R in 24 days. Animals irradiated at intervals of seventy-two hours had the best survival rate and the most unfavorable result was found in distributed daily irradiation. The tumor size was controlled most effectively by irradiation at intervals of twenty-four hours, in which the irradiation was completed early, and irradiation at intervals of seventy-two hours, in comparison with distributed daily irradiation, was more effective in suppressing growth of the tumors, while over-all time and total doses were the same. Stroma reaction viz. round-cell infiltration and many multinucleated tumor cells were observed in the histological study of the tumors irradiated at intervals of seventy-two hours. In the twenty-four group the tumor cells were degenerated strongly and slightly in the distributed dose group. Both of these groups had no visible stroma reaction. It is reasonable to presume that the stroma reaction is as important as destruction of tumor cells for prolonging life span. These results indicate that control of tumor-size is not necessarily proportional to survival. (NSA of Japan)

21958 RADIATION AND PROLIFERATIVE CELLS IN THE WHITE SERIES. Julio Rivera Bandres (Spanish Inst. of Haematology and Haemotherapy, Madrid). Nucl. Energy, 100-2(Apr. 1965).

Recent literature on the leukemogenic effects of radiation and the use of radiation in the treatment of leukemia is reviewed. Emphasis is placed on the radiosensitivity of leukocytes. (C.H.)

21959 THE PROBLEM OF RADIOSENSITIVITY. S. Hajdukovic (Boris Kidrich Inst. of Nuclear Sciences, Vinca, Yugoslavia), J. Karanovic, and N. Savkovic. Nucl. Energy, 105-8(Apr. 1965).

Factors that influence radiosensitivity are reviewed. Results are reported from two studies that demonstrate the direct relation between radiation injury and metabolic processes. The development of radiation injury as a function of degree of maturity was studied in hematopoietic cells of chick embryos. Exposure of incubated eggs with primitive hematopoietic cells to 700 R x radiation resulted in extensive necrosis of the majority of the cell population. Irradiation at the period of promegaloblast cell formation caused rare necrosis but many diverse morphological abnormalities, giant cells, and chromosome aberrations. Irradiation at the period of basophilic megaloblast formation resulted in the same type of radiation injuries but on a greatly reduced scale. It was concluded that the most radiosensitive hematopoietic cells are those in which preparations for intensive nucleic acid synthesis are present. Newborn rats were exposed to 600 R x radiation and examined for reproductive capacity when sexually mature. All females were sterile but not the males. Mating of the irradiated males with normal females resulted in a normal litter number but mortality during the first month was significantly reduced and the growth rate and weight of surviving animals was greatly reduced by the 4th month. In experiments where only the genital region was irradiated, the rats of the F_1 generation were normal, a few abnormalities were observed when the head only was irradiated, and when both the head and genital regions were irradiated the results were similar to those obtained by whole-body irradiation. Possible explanations are discussed. (C.H.)

21960 EVALUATION OF THE GRANULOCYTE BONE MARROW RESERVE: ITS ROLE ON THE PREVENTION AND CONTROL OF RADIATION EFFECTS. Carlo Sacchetti, Lauro Morra, Piero Boccaccio, and Aldo Ponassi (Universita, Genoa). Nucl. Energy, 109-14(Apr. 1965).

The in vivo labelling of the granulocytes with diisopropylfluorophosphonate-^{32}P ($DF^{32}P$) and the bone marrow reserve mobilization test with bacterial endotoxins, allowing an evaluation of the disponibility of the reserve, have been shown to be efficient techniques for the clinical assessment of granulopoiesis. An irradiation cycle has been observed to produce granulocytopenia associated with depletion of the bone marrow reserve. A 30 days interval after therapy was not sufficient to allow complete normalization of the granulopoiesis in all the studied subjects. The observed discrepancies between the granulocyte counts in the blood and the granulocytes in the bone marrow, suggest the opportunity of a quantitative and qualitative evaluation

of the bone marrow reserve. The intervals between successive irradiation cycles should then be decided on this basis. Similar criteria should be applied to control the integrity of granulopoiesis in subjects exposed to radiation hazard. The in vivo labelling with $DF^{32}P$ allows more detailed information, giving a quantitative evaluation of the granulocytes in the blood and in the bone marrow; however it takes a long time and its use is limited to specialized centers. On the contrary, the reserve mobilization test with bacterial endotoxins is simple, it does not require the use of radioisotopes and it can be performed in a very short time without bed rest in hospital. From the comparison between the two techniques it is possible to see that, in subjects with a normal reserve, the injection of bacterial lypopolysaccharides is followed by an increase in the number of the circulating granulocytes which is not lower than 3,000 cells per mm^3 and it is not accompanied by a left shift of the Arneth's classification. In subjects with depleted or subnormal bone marrow reserve, the evoked leukocytosis fails to develop and it is always followed by a significative left shift. (auth)

21961 RADIO-IMMUNOLOGICAL AND OTHER ASPECTS OF TISSUE TRANSPLANTATION, INCLUDING BONE MARROW. E. (A.) Szirmai (Div. of Nuclear Hematology, London-Stuttgart). Nucl. Energy, 124-7(Apr. 1965).

Recent literature on immune response to tissue transplants is reviewed. Results are reported from studies on the effects of whole-body x irradiation on response of mice to autologous and isologous bone marrow transplants. It is concluded that autologous and isologous bone marrow transplantations are compatible and will result in no reaction while with homologous and heterologous transplants there will generally be a subsequent rejection. (C.H.)

21962 OBSERVATIONS ON THE IMMUNOLOGY OF FASCIOLA HEPATICA INFECTIONS IN MICE AND RABBITS. D. L. Hughes (Allen and Hanburys Ltd., Ware, Eng.). Parasitology, 52: 4p.(1962).

The effect of x rays on the pathogenicity of F. hepatica in mice and rabbits is described. Mice infected with 10 to 20 viable unirradiated metacercariae usually die 3 to 4 weeks later; rabbits infected with 15 metacercariae do not die from the infection, but pass fluke eggs about 8 weeks later. Rabbits which had been infected with a single metacercaria passed fluke eggs which embryonated normally, showing that self-fertilization can take place. Little or no evidence of acquired immunity to F. hepatica is available, so that attempts were made to immunize rabbits and mice. One attempt involved exposure to x-irradiated metacercariae. It was shown that there is a minimum level of x irradiation of between 2 and 4 kR which so attenuates the flukes that mice do not die when infected with these metacercariae. These x-irradiated metacercariae excysted and reached the liver, but failed to grow normally and died in the liver 18 to 28 days afterwards. These flukes did not grow beyond 1 mm in length, whereas normal flukes are about 4 to 5 mm long at 28 days. Mice and rabbits which had previously been exposed to x-irradiated metacercariae were challenged with normal metacercariae. There was no difference between the fluke burdens of these animals and those of control animals. The serological responses as determined by agar gel diffusion were also examined in infected rabbits and also in rabbits injected with materials of fluke origin. Strong immunologic responses were seen, but these did not affect subsequent challenge with normal metacercariae. (BBB)

21963 COAGULATORY SYSTEM OF THE BLOOD IN RADIATION THERAPY. L. A. Baronina (Ternopol Medical Inst., USSR). Probl. Gematol. i Pereliv. Krovi, 9: No. 8, 35-6(Aug. 1964).

In radiation sickness, blood coagulation is disturbed and vascular wall permeability increased, which can lead to a hemorrhagic syndrome. With the increasing use of radiation therapy in surgery, the study of the coagulatory system of the blood in cancer patients treated with radiation therapy became significant. Investigations were made of 76 patients with cancer of the uterus, mammary glands, lips, and skin treated with different radiation doses. An increase in the time of recalcification, thrombin time, and free heparin of the blood was observed, along with a decrease in the percentage content of prothrombin, proaccelerin, proconvertin, and disturbed prothrombin, depending on the radiation dose. The most decided changes were observed in a group of patients receiving deep roentgenotherapy for cancer of the femal genitalia. Short-focus roentgenotherapy caused no changes. (CFSTI)

21964 THE IMPORTANCE OF COMPETITIVENESS OF RADIOSTERILIZED MALES IN MOSQUITO-CONTROL PROGRAMS. David A. Dame and Claude H. Schmidt (Dept. of Agriculture, Orlando, Fla.). Proc. Ann. Meeting New Jersey Mosquito Exterm. Assoc., 49: 165-8(1962).

In the sterile-male-release program conducted at Lake Okeechobee, Fla. during 1959 and 1960 an initial population decline occurred, but by the end of the test period the Anopheles quadrimaculatus population had increased enough to show that the sterile males had not seriously influenced the ability of the wild population to reproduce. It was not known whether the failures were due to a lack of competitiveness on the part of the released males or lack of sufficient numbers of these sterile males to overwhelm the wild population. Therefore, the effect of radiosterilization on competitiveness was reinvestigated. The preliminary studies utilized males exposed to γ radiation as 24-hr-old pupae. This treatment reduced the sexual vigor of the male. It was later found that by irradiating A. quadrimaculatus pupae more than 24 hr old, the resulting males are much more competitive. Similar studies with Aedes aegypti showed that adult males exposed to 8000 or 10,000 R of γ radiation as pupae either 24 hr old or older are not competitive under lab conditions. Differences in A. aegypti pupal mortality and adult viability were demonstrated to be dependent upon the age at which the pupae were irradiated. Pupae 3, 11 22, and 45 hr old were exposed to 8000 and 12,000 R of γ radiation. The younger pupae were the most sensitive to radiation. Among pupae irradiated at 3 hr of age, the emergence and viability were greatly reduced at both doses. There was little reduction in emergence among pupae irradiated at 11 hr of age, but viability was reduced seriously at the higher dose and slightly at the lower dose. There was no demonstrable effect with either radiation dosage on 22- or 45-hr-old pupae. To ascertain whether lab-reared males will mate with wild females, a technique was devised to label the sperm of the lab-reared A. quadrimaculatus males by exposing them as larvae to radiophosphorus. These adults are not harmed by their radioactivity and mate normally under lab conditions. Females mated with these labeled males are readily detected by radioautographic methods due to the presence of the radioactive sperm in their spermathecae. It is planned to utilize this technique in the field by radioautographing captured wild females to determine whether they have been inseminated by released ^{32}P-labeled lab-reared males. (BBB)

21965 EFFECTS OF TRYPSIN ON ULTRAVIOLET IRRADIATED-MYOSIN A. George Kaldor and Sandra Weinbach (Jewish Chronic Disease Hospital, Brooklyn). Proc. Soc. Exptl. Biol. Med., 118: 1046-8(Apr. 1965).

Myosin A was exposed to ultraviolet radiation followed by trypsin digestion and the products were studied by ultracentrifugation, diffusion, electrophoresis, and measurements of ATPase. Results indicated that uv irradiation induced major structural changes in the heavy meromyosin component of the myosin A molecule and caused a reduction of ATPase activity. Reaction mechanisms involved are discussed. (C.H.)

21966 PATHOGENESIS OF CHRONIC AFTER-EFFECTS OF IRRADIATION. S. N. Alexandrov (Central Research Inst. of Roentgen-Radiology, Leningrad). Radiobiologiya, 5: 61-7(1965). (In Russian)

The chronic after-effects of irradiation are considered to be destructive, atrophic, and dystrophic processes combined with recovery and proliferation tissue reactions.

The net result is a shortening of the life span. An experiment on mice is reported, in which the percentages of pathological cells at 2 to 22 months after 200 R gamma irradiation were found to be 3 to 9 times normal values. Following a review of the literature (36 references), it was concluded that post-irradiation effects are due to an insufficiency rather than to an absence of recovery processes. (IIC-M.G.)

21967 INVESTIGATION OF OPTICAL PROPERTIES OF NATIVE CHLOROPHYLL OF PLANT LEAVES OF GAMMA-IRRADIATED PISUM SATIVUM SEEDS. E. K. Uzorin and A. M. Kuzin (Inst. of Biological Physics, Moscow). Radiobiologiya, 5: 119-25(1965). (In Russian)

Absorption spectrums were determined for chlorophyll extracted from the leaves of seedlings grown from Pisum sativum seeds that had been irradiated to 0.1 to 10 kR (^{137}Cs). Changes in the native chlorophyll depended directly on the dose to the seeds. The results indicate that photosynthesis requires activation of the pigment in both the long- and shorter-wave absorbing part of the spectrum. Light absorption by accessory pigments is responsible for the Emerson effect (e.g., Science 123: 673 (1956)). (ICC-M.G.)

21968 ON THE SUBJECT OF THE ENVIRONMENTAL FACTORS IN THE CARCINOGENESIS OF PRECANCEROUS LESIONS AND OF THE EARLY DIAGNOSIS OF TUMORS. Paola Craxi (Universita, Palermo, Italy). Rass. Clin.-Sci., 40: 109-13(Apr. 1964). (In Portuguese)

The role of various chemical and physical agents, including ionizing radiations, in carcinogenesis is reviewed. (BBB)

21969 RADIATION ALLERGY IN RELATION TO THE VARIOUS WAVE LENGTHS. Q. Falchi and G. Marsico (Universita, Genoa). Riforma Med., 77: 897-904(Aug. 17, 1963). (In Italian)

This study deals with the histamine reactions to ionizing radiation of various energies in four cancer patients with allergies. Case one, which showed a malignant tumor spreading over the entire hard palate, was treated on alternate days with 200 and 250 R of 200-kv x rays, over a field of 4.5 × 7 cm and a pendulum depth of 6.5 cm and rotating angle of 150°, with a total dose of 2685 R in 20 days. One month later this case was readmitted and treated with a total of 4000 R at which point radiotherapy was interrupted due to neurasthenia and anorexia. Cobalt-60 therapy was begun, locally with six tubes of five mg each and total dose of 6000 R and with telecobalt therapy at 3000 R total dose. Case two involved mammary malignancy treated with a total dose of 6000 R of telecobalt therapy. Case three showed an epithelioma which was treated with x-ray therapy to a total focal dose of 6000 R. Case four was one of ulcerated epithelioma treated with 50-kv x-ray therapy of a total dose of 7000 R. The tumor, recurring after 16 months, was treated again with superficial radiotherapy to a total dose of 6000 R. In all four cases, normal remission of the lesions was observed. The patients' preexisting allergic state did not reveal any new sensitization attributable to radiotherapy. When ^{60}Co therapy was used for the principal irradiation or as follow-up to x-ray therapy, allergic radiation reactions were never observed. Based on erythema, the depth-penetrating ^{60}Co γ radiation showed a lower biologic effectiveness in skin in comparison to the less penetrating x radiation, although the histological variations were more or less identical. Radiotherapy given as small total doses and low kv range, even given as repeated cycles, did not show any particular change in allergic reactions. Thus, x-ray therapy, which has a greater effect on superficial tissues, did not appear to enhance tissue sensitization as compared to harder radiation (of shorter wavelength) such as ^{60}Co. The elevated irradiation intensity (R/min) with ^{60}Co might be expected to have produced rapid and massive histamine liberation, but this did not occur. The total daily dose, however, appeared to have considerable importance. This could be confirmed by the absence of allergic reactions with reduced and fractionated doses and their frequency with soft x-ray therapy during which the daily doses were very high. (BBB)

21970 MODIFICATION IN THE ATP-CREATINE SYSTEM AFTER WHOLE-BODY IRRADIATION. G. Sanna (Ospedale Civile, Cesena, Italy). Riv. Patol. Clin., 18: 473-81(Sept. 1963). (In Italian)

This study is concerned with the changes in plasma creatine and creatinine following whole-body irradiation. Concomitantly the plasma adenosine triphosphate (ATP) values were measured to determine whether irradiation causes a disorder in the ATP-creatine metabolic system. Adult rats received 600 R of 180-kv x-ray whole-body irradiation in a single session and were sacrificed in groups of five at intervals of 24 hr, 48 hr, 10 days, and 20 days. Ten animals were kept as controls. The plasma values in the controls were: creatine 3.76 mg%, creatinine 0.72 mg%, and ATP 21.2 mg%. The irradiated animals showed the following values after 24 hr, 48 hr, 10 days, and 20 days: creatine 3.60, 3.24, 3.82, 3.90; creatinine 0.66, 0.72, 0.76, 0.78; ATP 15.68, 17.46, 20.14, and 20.44. Thus, all three levels fell 24 to 48 hr postirradiation then returned to normal. Irradiation may inhibit creatine production either through direct action upon a transmethylase or through indirect action upon the oxidative phosphorylation processes with subsequent deficiency in the ATP availability causing enzymatic inactivation. This dual mechanism could be the reason for the decline in creatine and ATP levels which was observed in the irradiated animals. Depression of plasma creatinine is a direct consequence of creatine depletion. These results tend to disprove the hypothesis that postirradiation creatinuria is caused entirely by the mobilization of muscular creatine from reduction of glycolysis. It is suggested that the creatinuria is caused by a glomerular and tubular kidney lesions sustained by irradiation followed by depression reabsorption mechanisms. (BBB)

21971 THE ENDOCRINE GLANDS IN EXPERIMENTAL RADIATION SYNDROME. J. Comsa (Universitat Saarlandes, Homburg/Saar, Ger.). Strahlentherapie, 126: 366-85(Mar. 1965). (In German)

Observations concerning the metabolic influence of ionizing radiations are summarized. Topics discussed include the modifications of metabolisms following irradiation and the influence of the nutritional condition upon the resistance irradiation. Observations suggest the supposition of possible endocrine disorders in irradiated animals. They do not demonstrate it unequivocally. The consequences of ionizing irradiation upon the morphology and the physiology of various endocrine glands are reviewed (hypophysis, adrenal, thyroid, gonads, and thymus). The consequences of a total irradiation upon the hypophysis, the thyroid, and the adrenal appear to change in relation to the dose of irradiation. A slight irradiation seems to induce a stimulated condition of these glands, whereas a massive irradiation is followed by suppression of their activity. (tr-auth)

21972 CYTOLOGICAL INVESTIGATIONS ON THE EFFECTS OF IONIZING RADIATION ON NORMAL, REGENERATING, AND BLASTOMATOGENIC TISSUES. PART 3. ELECTRON MICROSCOPIC INVESTIGATIONS ON THE EFFECTS OF IONIZING RADIATION ON THE WALKER CARCINOMA. Heinz Karl Parchwitz, Elisabeth Wittekindt, and Wolfgang Wittekindt (Universitat, Munich and Universitat, Kiel). Strahlentherapie, 126: 386-406(Mar. 1965). (In German)

Walker-carcinomas which received a single x irradiation with 5000 R were excised 6, 24, 48, and 96 hours after irradiation and studied with an electron microscope. Lobulated nuclei with a loosened interior structure and nucleoli, distributed over the nuclear space (granulas of which had apparently passed through the interrupted nuclear membrane), were found frequently in the irradiated tissue at an early stage after irradiation. The stick-shaped mitochondria which were perinuclear showed, frequently, a reduced interior structure. Later on, de-differentiated cytoplasm with very reduced ergastoplasm, lipoid accumulations, and increased Golgi-complexes were observed. In spite of

numerous communications between extremely enlarged nuclei with dissociated karyoplasm and cytoplasm, no passage of nuclear material could be found. The nucleoli were frequently vacuolized and partially thickened. Prior to the de-differentiation, the cells were characterized by an ergastoplasm with numerous membranous structures. Results were compared with those obtained with a light microscope and discussed considering the periodic course of cytomorphologically detectable radiation reactions. (tr-auth)

21973 INVESTIGATIONS OF THE EFFECTS OF CATALASE AND PEROXIDASE ON THE RADIOINDUCED MUTABILITY OF DROSOPHILA MELANOGASTER. Erwin Magdon and G. Winterfeld (Robert-Rossle-Klinik, Deutsche Akademie der Wissenschaften, Berlin). Strahlentherapie, 126: 427-31(Mar. 1965). (In German)

Solutions of peroxidase or catalase were injected abdominally into adult males of Drosophila melanogaster of the wild Berlin strain prior to an x irradiation with 1500 R. Using the M-5-method, the rate of recessive, sex-bound lethal factors in the different stages of spermatogenesis were determined. Peroxidase and catalase decreased the radiation induced mutation rate only in those germ cells which were still in a stage of division at the time of irradiation. There was no significant influence upon the mature sperms and spermatids. (tr-auth)

21974 RADIOGENIC INJURIES TO BONES AND THE SURROUNDING SOFT TISSUE AFTER TELECOBALT IRRADIATION. PART II. EXPERIMENTS ON GUINEA PIGS, IRRADIATED WITH 10,000 R ^{60}Co. Juergen Kollath (Strahlentherapeutische Klinik am Stadt. Krankenhaus Moabit, Berlin). Strahlentherapie, 126: 432-48(Mar. 1965). (In German)

Radiation induced changes in the femurs and soft tissues of the guinea pig were investigated histologically after ^{60}Co-irradiation with 5000 R and 10,000 R. Bone tissue was found to be very resistant to the ultrahard ^{60}Co-gamma-rays. There was, however, considerable destruction of the irradiated soft tissue. From these results it can be concluded that human bone tissue will not be damaged with radiation doses used in the telecobalt treatment of deeper located tumors. The destruction of soft tissue by ^{60}Co radiation must be investigated in more detail. (auth)

21975 INVESTIGATION OF THE CALCIUM METABOLISM IN THE EPI- AND METAPHYSIS AFTER LOCAL X IRRADIATION. PART VII. DEPENDENCE OF THE GENERAL REACTIONS ON AGE. Arnost Babicky, Jaromir Kolar, and Lubos Vyhnanek (Univ. of Prague). Strahlentherapie, 126: 449-53(Mar. 1965). (In German)

The influence of age on the course of a generalized metabolic reaction in the total skeleton of male white mice, caused by local x radiation damage, was investigated. Calcium-45 was used as a tracer. There was a reduced response with increasing age, which is in agreement with general biological rules. (tr-auth)

21976 ACTIVITY CHANGES OF THE GLUTAMATE-OXALATE-TRANSAMINASE AND GLUTAMATE-PYRUVATE-TRANSAMINASE IN THE HEART, LIVER, KIDNEYS, AND SERUM OF WHOLE-BODY IRRADIATED RATS. Heribert Braun, Guenter Hornung, and Meinhard Neumeyer (Universitat, Wurzburg, Ger.). Strahlentherapie, 126: 454-64(Mar. 1965). (In German)

White Wistar rats with an average weight of 230 g were total-body irradiated with 600 R x radiation. The glutamate-oxalate-transaminase and glutamate-pyruvate-transaminase content in heart, liver, kidney, and blood serum was measured 2 to 12 days after irradiation. Significant changes in enzyme levels were observed. Increase of GOT-activity in heart and kidney was noted 4 days after irradiation. During the following days the activity in these organs returned to normal values. There was a decrease of the GOT-activity in liver and serum after irradiation. The GPT-activity was decreased in heart and liver, a result statistically proven after the 6th and 8th day respectively. After an initial decrease, the activity of the kidney was significantly increased at the 6th day followed by a linear decrease to normal value. A general decrease of the GPT-values was observed in serum. For serum and single organs both enzymes (GOT and GPT) showed similar behavior in their reactions to irradiation. This was particularly true in liver and kidney. (tr-auth)

21977 INACTIVATION AND PHOTOREACTIVATION OF THE T-EVEN PHAGES AS A FUNCTION OF THE INACTIVATING ULTRAVIOLET WAVELENGTH. C. A. Cavilla and H. E. Johns (Univ. of Toronto). Virology, 24: 349-58(Nov. 1964).

The Escherichia coli bacteriophages T2 and T6 are twice as sensitive to uv radiation as the closely related strain T4. This difference in sensitivity is due to the presence of the v gene in T4 (absent in T2 and T6), which operates in the dark, acts by repairing about 50% of the original uv lesions, possibly by one or more enzymatic steps. Another repair phenomenon, photoreactivation (PR), can be brought about by irradiating the phage-bacterium complexes with light in the range of 300-400 mμ. This type of repair will remove 50% of the lesions produced in T2 or T6, but only about 20% of those produced in T4. If the v gene is responsible for the difference in uv sensitivity between T2 and T4 at all wavelengths, and the v gene repairable lesion is closely identified with the photoreactivable lesion, as assumed at present, it is anticipated that a larger fraction of the lesions produced in T2 would be photoreactivable as the wavelength of the uv radiation used was increased. To investigate this, T2, T4, and T6 were inactivated by radiations in the range of 220-302 mμ and max PR was performed. The results showed that the ratio (R) of the mean lethal dose for the inactivation of plaque-forming ability of T4 to that of T2, in the dark, increases gradually with wavelength from a value of 2.0 at 230 mμ to 3.3 at 297 mμ and finally rises sharply to a value of 4.0 at 302 mμ. The photoreactivable sector in T2, measured as a function of the wavelength of killing, was almost independent of wavelength, so that a variation in the photoreactivable sector cannot account for the observed change in the ratio R. It is shown that the v gene present in T4, but not in T2, is able to repair a larger and larger percentage of the uv lesions as the wavelength of the damaging radiation is increased. This indicates that at long wavelengths (302 mμ) some other type of lesion is being produced which can be repaired by the v gene but cannot be photoreactivated. (BBB)

21978 MULTICENTRIC ANGIOPLASTIC RETICULOENDOTHELIOMATOSIS OF THE LIVER AFTER THOROTRAST ARTERIOGRAPHY. P. Kemnitz (Institut fur Pathologie, Magdeburg, Ger.). Zentr. Allgem. Pathol. Pathol. Anat., 106: 189-97(Aug. 31, 1964). (In German)

Development of neoplasia as a result of ThO_2 deposition in the liver is described in a 55-yr-old man who died as a result of rupture of the liver and hemorrhage into the peritoneum. His history showed that either 20 or 27 yr earlier he had undergone cerebral arteriography using Thorotrast, following an automobile accident. Histopathologic studies at autopsy showed the presence of ThO_2 particles in the liver, spleen, lymph nodes, bone marrow, and diaphragm. In spleen and lymph nodes the radioactive particles were completely surrounded by hyalinized scar tissue. However, the apparently low uptake of the particles by reticuloendothelial cells in bone marrow caused no qualitative or quantitative changes. The liver showed the most pronounced changes, with diffuse distribution of ThO_2 particles in periportal zones; in the sinusoids the Kupffer cells showed lower uptake. These cells were presumably irreparably injured by ThO_2, which would be expected to localize in these cells soon after its injection. A prominent finding in the liver was a malignant hemangioma, which was the site of the fatal liver hemorrhage. A cavernous, blood-filled space of the neoplastic process had ruptured the liver capsule. The finding of ThO_2 particles in the diaphragm has only rarely been reported previously; presumably lymphatic drainage from the liver through this tissue accounts for their deposition there. (BBB)

21979 THE CORPUSCULAR DECAY PRODUCTS OF RADON AND THE LUNGS. W. Frey. Zentr. Biol. Aerosol. Forsch., 12: 1-11(June 1964). (In German)

The corpuscular decay products of radon that are inhaled have their greatest effect, not in the lungs, but in the bronchi. The α radiation emitted damages the redox system of the SH ferment, leads to anoxia, and promotes carbohydrate utilization by fermentation and therefore the formation of a new cell strain with excessive growth. Air impurities, specifically As_2O_3 and polycyclic hydrocarbons, work similarly and can increase the effect of background radiation. (tr-auth)

21980 THE EFFECT OF SOME COMPLEX MICROELEMENT COMPOUNDS ON THE PHAGOCYTIC ACTIVITY OF LEUKOCYTES AND THE AGGLUTININ FORMATION IN THE NONIRRADIATED AND IRRADIATED RABBITS. A. I. Nikolaev, Kh. R. Mukhamedzhanov, and S. M. Khalifaev. Zh. Mikrobiol. Epidemiol. i Immunobiol., No. 2, 90-5(Feb. 1965). (In Russian)

A study was made of the effect produced by cobalt, iron, and copper compounds with biologically active substances on the phagocytic activity of leukocytes and the intensity of agglutinin formation in nonirradiated and irradiated rabbits exposed to an irradiation dose of 500 R. The compounds tested in these experiments were coamide, a complex compound of cobalt chloride with nicotinic acid amide; Co-labeled vitamin B_{12}; feramide I, a complex compound of iron chloride with nicotinic acid amide; feramide II, a complex compound of iron sulfate with nicotinic acid amide; and copper glutamide, a complex compound of copper chloride with glutamic acid. The complex microelement compounds stimulated the antibody formation and increased the phagocytic activity of leukocytes in the nonirradiated rabbits. (trans-auth)

21981 STUDIES ON RADIATION MUTAGENESIS IN MICRO-ORGANISMS. R. F. Kimball (Oak Ridge National Lab., Tenn.). p.227-34 of "Genetics Today." New York, Pergamon Press, 1964.

A major goal of studies on radiation mutagenesis is to discover the molecular basis for the initial radiation action for the steps that lead to final mutation. This problem concerns not only the radiation chemistry of the chromosome, but also the ways in which the cell converts some molecular lesions to mutation and repairs or eliminates others. Thus it is essential to study mutagenesis at the cellular level to be able to choose from the numerous alternatives provided by radiation chemistry those that are important for mutagenesis. Data are reviewed from recent studies with bacteria, bacteriophage, and Paramecium aurelia on the biological effects of specific molecular alterations produced by DNA by ultraviolet radiation. Several major conclusions from this work are summarized. (C.H.)

21982 REPORT OF THE SYMPOSIUM ON RADIOSENSITIVITY. Basic Research Clinical Applications Held in Quebec, Sept. 4-5, 1962. Quebec, Laval Medical, Inc., 1963. 194p. (CONF-620903)

Separate abstracts were prepared for three of the 22 papers included. Nineteen papers were abstracted previously and appeared in NSA Vol. 17; see numbers 10356, 26990, 27047, 27135, 27136, 27137, 27138, 27139, 27141, 27142, 27144, 27145, 27147, 27148, 27149, 27150, 27209, 28613, and 28741. (C.H.)

For abstracts of individual papers see: 21983, 21984, and 22385.

21983 RESEARCH OF THE MOLECULAR NATURE OF CELLULAR RADIOSENSITIVITY. J. L. Van Lancker (Univ. of Wisconsin, Madison). p.63-8 of "Report of the Symposium on Radiosensitivity." Quebec, Laval Medical, Inc., 1963. (In French)

Results are summarized from in vivo and in vitro studies of the effects of x radiation on metabolism in regenerating liver. The data indicate that x radiation inhibits DNA synthesis in regenerating liver and the inhibition is proportional to the logarithm of the radiation dose and independent of the time elapsing between hepatectomy and irradiation. The results suggest that the radiosensitive target is present during interphase and that the latent cellular damage becomes apparent when cell divisions are induced in the liver. The interference with DNA synthesis may be only a secondary reaction resulting from the inhibition of kinase and polymerase synthesis and from the inability of irradiated nuclei to incorporate the final precursors of DNA even when an excess of enzyme is present. (C.H.)

21984 RADIORESISTANCE. D. G. Baker (Univ. of Toronto). p.95-103 of "Report of the Symposium on Radiosensitivity." Quebec, Laval Medical, Inc., 1963.

Results are summarized from studies in mice and rats that suggest it is possible to increase the radioresistance of animals by low-dose serial radiation exposures or by low-dose exposure of fetal animals. Data are presented from a series of experiments on adaptation to radiation and reactions involved in recovery from radiation injury. Observations are reported for rats exposed to whole-body γ radiation at various dose rates up to 100 R/23-hr day, rats exposed to a fixed dose (630 rads) of x radiation delivered at dose rates of from 1 to 180 rads/min, mice exposed to a fixed dose of 200 R whole-body x radiation at a constant dose rate of 40 R/min, and mice exposed to x radiation at various dose rates for 96 hr. Mechanisms that are involved in altered sensitivity to ionizing radiations are discussed. It is concluded that there are inherent differences in radiosensitivity of cells in a given tissue, that radiosensitivity of single cells varies with time depending on the stage of mitosis and metabolic activity of the cell, that radiation destroys the most sensitive cells leaving the more resistant ones to proliferate and repair the injury, and that a process of selection for radioresistance may occur in some cells and tissues. (C.H.)

21985 THE PERSISTENCE OF AK LEUKEMIA IN NORMAL OR X-IRRADIATED SUSCEPTIBLE AND NONSUSCEPTIBLE MICE. James Alexander Elder Halkett. Thesis, Boston Univ., 1964. 105p.

The persistence of AK leukemia in the spleens of susceptible and nonsusceptible mice was investigated under various experimental conditions in order to demonstrate intermediate steps in the homograft rejection and to study the effect of x irradiation on graft rejection or acceptance. Two strains of mice were used, the inbred AKR/J strain and a random bred Swiss strain. An AK leukemia 100% lethal to the AKR/J strain but not lethal to the Swiss strain was used. Whole body x irradiation at a dosage of 400 R was used with 10 mice to a cage. A study of the growth characteristics of various concentrations of leukemia showed that a linear relationship exists between average survival in days and the logarithm of the dose. The relation between these concentrations and persistence was also investigated. Each concentration was characterized by a rise phase, a maximum phase, and a rejection phase, and the time and value of the maximum phase were found to be related directly to the concentration of the inoculum. It appeared that an optimal concentration of the leukemic factor was approached, following which rejection took place. A relationship was found between the time of x irradiation, the time of injection of leukemia, and the survival of Swiss mice. A greater number of Swiss mice died when irradiation was given before injection than following injection. When irradiation came before injection, the optimal concentration was exceeded in 54% of the mice. Near normal (like non-irradiated) results followed irradiation given 2 days after injection. Experiments with AKR/J mice showed that mice irradiated a few days after injection survived longer than those irradiated immediately after injection. A possible relationship between resistance and x-irradiation action was indicated when persistence was studied in resistant Swiss mice exposed to x irradiation. A hypothetical model suggesting intermediate steps is proposed to account for the results of this paper as well as those reviewed. (Dissertation Abstr., 25: No. 5, Nov. 1964)

21986 A GENETIC STUDY OF THE RA CELL, A NEW LINE OF HUMAN AMNION, WITH SPECIAL REFERENCE TO CYTOGENETICS, RADIATION EFFECTS AND ENZYME SYSTEMS. James Dale Regan. Thesis, Honolulu, Univ. of Hawaii, 1964. 93p.

The RA ("recovered amnion") cell is a continuous line derived by spontaneous alteration from normal amnion. It is basically an epithelioid type but individual clones exhibit considerable pleomorphism. The chromosome number was monitored for two years. During this period the chromosome number appeared to be variable with a modal number between 55 and 75, with occasional cells counting 80 and above. More recently a number of cells were subjected to detailed karyotyping. A high proportion of these were found to have 70 chromosomes and are what appear to be triploid cells with an additional centric fragment smaller than and clearly different from members of the G group. X irradiation produces the arborescent giant cells reported in other irradiated epithelioid cells. Cultures counted 6 days after irradiation had 70% survivorship of the control (non-irradiated) cultures at 100 roentgens, 27% at 400, and 16% at 1200. Detailed studies of certain enzymes present in normal and cortisone-treated cultures were made by means of the starch-gel zymogram technique. (A.G.W.)

21987 THE ESTABLISHMENT OF TRIBOLIUM CONFUSUM DUV. POPULATIONS AFTER STRESS BY PARASITISM AND X-IRRADIATION. Frank Herbert Dowell. Thesis, Knoxville, Univ. of Tennessee, 1964. 109p.

The ability of T. confusum populations to establish themselves and reach equilibrium after the stresses of irradiation and parasitism was measured. The experiment involved eight groups (all combinations of parasitism, no parasitism, 3 levels of irradiation, and no irradiation) with an original sample size of 30 and three replicates. Measurements were made of the numbers of adults at a given time and the times required to reach a given number of adults. Irradiation levels were 3000, 5000, and 15000 R. It was concluded that there is a difference between non-irradiated, non-parasitized and non-irradiated, parasitized populations in the ability to establish themselves (the latter having less ability), but apparently this difference disappears as the total size of the population increases with population age. There is no difference between irradiated, parasitized and irradiated, non-parasitized populations in ability to establish themselves regardless of the total size of the population. The results may be explained in terms of the hypothesis that both parasitism and irradiation reduce reproductive potential, that these reductions are additive, and that the reduction caused by parasitism is directly proportional to the level of parasitism. (A.G.W.)

21988 EFFECTIVENESS OF RECURRENT SELECTION AND RECURRENT IRRADIATION IN OAT BREEDING. Fouad Hassan Khadr. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 131p.

Oat populations derived from irradiated Clintland, irradiated Beedee, the hybrid of Beedee x Clintland, and the irradiated hybrid were used as genetic sources to initiate a cycle of recurrent selection and a second cycle of irradiation. The five lines with the highest 100-seed weight from each source were crossed in a diallel series and also reirradiated with thermal neutrons. The field experiment was grown in a randomized block design with 3 replications at Ames, Iowa. The progress from selecting the parental lines for 100-seed weight was as great or greater than predicted in both the irradiation-derived and hybrid-derived materials. No change occurred in the mean heading dates or plant heights (nonselected characters). The expected genetic advances from another selection cycle were high in all populations, and equal gains were expected from both the hybrid- and irradiated-derived populations. The highest actual and predicted genetic gains occurred in the irradiated-hybrid population, suggesting that irradiation would complement hybridization to maximize genetic variability. Expected genetic variability from combining three genotypes and three levels of irradiations were calculated to test if irradiation-induced and natural variability were additive. A hybrid background somewhat depressed the expression of induced variability. Variability for heading date (a qualitatively inherited attribute) was approaching a maximum with three doses of irradiation, but for seed weight and plant height (relatively complex attributes) variability continued to accumulate through four doses. Recurrent irradiation did not increase sterility in the populations. Intrapopulation correlations between seed weight and sterility were not significant. (Dissertation Abstr., 25: No. 5, Nov. 1964)

21989 RADIOSENSITIVITY AND REPAIR IN DIFFERENT GERM CELL STAGES OF DROSOPHILA. F. H. Sobels (Rijksuniversiteit, Leiden, Netherlands). p.235-55 of "Proceedings of the 11th International Congress on Genetics, The Hague, Sept. 1963." Oxford, Pergamon Press, 1964.

An outline is presented of the various factors involved in determining the final yield of genetic changes, and a detailed analysis is given of the causes underlying the various differences in sensitivity in germ cells of Drosophila, which is well suited to genetic analysis and to further elucidate the mutation process. Repair and differential radiosensitivity in spermatids and sperm are treated in detail. For these experiments 1-day-old males carrying a ring-shaped X-chromosome of the constitution XC^2yB were used, so as to restrict the induced lethals to point mutations and possibly small deletions. The mutational response in successive stages of spermatogenesis was studied by making 2-day brood changes with 6 females per male per brood. Evaluation of factors determining initial sensitivity and those involved in repair processes shows that oxygen plays an important role in both steps of the mutation process. Thus, the finding that equal yields of mutation were obtained from spermatids by irradiation with 1000 R in O_2, as with 3000 R in N_2, under conditions of inhibited repair (N post-treatment), shows that the degree of oxygenation determines the amount of potential damage induced. After irradiation in O, not only is more damage induced, but, in addition, the capacity to undergo repair is greatly restricted. This was demonstrated by the observations that following irradiation in O, post-treatments are much less effective in reducing the yield of mutations, than after irradiation in N. This and the observation that, after irradiation in N, O or air favors postirradiation recovery in spermatids, but inhibits this process in sperm, explains why in earlier experiments irradiation in N, followed by air, levels off the difference in sensitivity between sperm and spermatids, although higher yields were still obtained from spermatids than from sperm after radiation in O. Thus postirradiation recovery is favored by N in sperm and by O in spermatids, illustrating how generalizations between different cells, even within the same organ system, may lead to errors in interpretation. The difference in response to radiation between spermatids and sperm is also indicated by the contrasting effects obtained after pre-treatment with both ribonuclease and chloramphenicol. This indicates that inhibition of protein synthesis, perhaps by making more oxygen available, influences the intermediate steps of the mutation process. It is concluded that the picture of the mutation process, now emerging, involves numerous intermediate factors and their possible interactions which determine the final yield of detectable genetic changes. This is in contrast to the earlier notion of irreversible damage, which was fixed at the time of radiation exposure. (BBB)

21990 EFFECT OF LOW RADIATION INTENSITIES ON MAN. F. J. Jankowski (Rutgers Univ., New Brunswick, N. J.). 8p. (CONF-654-67)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

An analog between the biological effects of certain inorganic chemicals and the effects of low intensities of radiation is presented for man. Data on the nutritional needs and toxicity of Fe, I, Al, Cu, Hg, Mg, Mn, and Zn are re-

viewed in terms of need and thresholds for toxic effects. Possible applications of the analog in biological studies are discussed. (C.H.)

21991 EFFECTS OF GAMMA IRRADIATION ON TRYPANOSOMA BRUCEI. A. Gubbiotti, A. Begliomini, and T. Frescura (Universita, Perugia, Italy). 7p. (CONF-631002-1)

From 12th National Congress on Microbiology, Perugia, Italy.

Results are reported from some experiments on Trypanosoma brucei treated with γ rays from a ^{60}Co source. With dosages varying from 5,000 to 300,000 rads the trypanosomes remained viable (as determined by motility) and morphologically unchanged in both fresh and in fixed and stained preparations. With dosages from 400,000 to 600,000 rads the motility was progressively reduced but the morphology remained unchanged. Starting at dosages of 35,000 rads a definite decrease in infectivity of the organisms was induced as indicated by a lengthening of the time in which experimental mice died as compared to the controls. At dosage of 50,000 rads the infective power of Trypanosoma brucei for mice was completely inhibited. In a study on the behavior of mice surviving after inoculation of trypanosomes irradiated with 100,000 and, respectively, 200,000, 300,000 rads with fully viable (as determined by motility) and with 400,000, 500,000 and 600,000 rads (the motility of organisms was progressively reduced), it was observed that these animals had a normal susceptibility as the controls. In the above mentioned experimental conditions the inoculation of irradiated trypanosomes did not induce some immunity or resistance phenomenon in mice. (auth)

21992 STATUS REPORT ON THE SPACE RADIATION EFFECTS ON THE APOLLO MISSION. John Billingham, Donald E. Robbins, Jerry L. Modisette, and Peter W. Higgins. 42p. (CONF-720-24)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

The four papers in this status report present the current approach to the space radiation environment's effect on the Apollo lunar missions. This approach is based upon an analysis of the radiation dosages acceptable in a single emergency exposure by an astronaut during a lunar mission, the accurate determination of the radiation environment to be encountered during the lunar missions, the application of the probabilities of encountering this environment to the principles of good design, and the use of operational procedures to supplement spacecraft design to achieve the desired radiation protection. All of these factors should be considered together in order to describe in meaningful terms the radiation effects to Apollo. (auth)

Radiation Effects Therapy and Countermeasures

21993 (NP-14779(p.29-44)) PHARMACOLOGICAL OR TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. I. THE INFLUENCE OF VARIOUS CHEMICAL COMPOUNDS ON RADIATION LETHALITY IN MICE. V. J. Plzak, M. Root, and J. Doull (Chicago Univ., Ill. Air Force Radiation Lab.).

Thirty-five compounds were evaluated for protective activity against radiation lethality in CF_1 male mice. Of these, eleven were significantly radioprotective against a lethal dose of whole-body x irradiation as evidenced by the fact that 10% or more of the mice so pretreated survived for at least 30 days after the exposure. (auth)

21994 (NP-14779(p.45-63)) PHARMACOLOGICAL OR TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. II. DOSE-MORTALITY RELATIONSHIPS FOR SEVERAL RADIOPROTECTIVE AGENTS. V. Plzak and J. Doull (Chicago Univ., Ill. Air Force Radiation Lab.).

Studies were carried out to determine the dose reduction factor (DRF) for six radioprotective agents in CF_1 male mice exposed to whole-body x ray doses of 600 R through 900 R. The DRF calculations were based on the ability of the agents to reduce radiation mortality at 30 days after exposure and were calculated using a maximum likelihood estimate procedure which has been programmed for IBM 7094. The results of these studies indicated that the most effective agent included in the present series of compounds was 1-thioglycerol (DRF = 1.28). DRF values of about 1.2 were obtained with 2-benzoxazolethiol, N,N'-bis-(2-hydroxyethyl) dithiooxamide, B,B-dimethyl aminoethyl isothiouronium sulfate, and N,N'-di(9-xanthenyl) dithiooxamide. The dimethylammonium salt of dimethyl dithiocarbamic acid was the least effective of the compounds tested in that it exhibited a DRF of 1.16 against radiation lethality in mice. Studies were carried out to investigate the effect of increasing the dosage level of p-aminopropiophenone (PAPP) on the radioprotective activity of this agent against the acute lethal effects of x ray exposure in mice. Increasing the dosage level of PAPP from 15 mgm/kgm IP to 45 mgm/kgm IP did not increase the protective effect of this agent against whole-body x ray exposure in mice. (auth)

21995 (NP-14779(p.64-9)) PHARMACOLOGICAL OR TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. III. STUDIES ON THE RELATIONSHIP BETWEEN SPLEEN OXYGEN TENSION AND RADIOPROTECTION IN MICE. A. Hasegawa and H. D. Landahl (Chicago Univ., Ill. Air Force Radiation Lab.).

The LD_{50} values in mice forced to breathe 10%, 7%, or 4.6% oxygen during x-ray exposure were 620 R, 860 R, and 1000 R respectively. The LD_{50} values in the mice maintained at 10% oxygen for a period of 10 minutes but irradiated under the same conditions as above were 590 R at 10% and 995 R at 4.6%. Thus, prior administration of 10% oxygen did not alter the survival of these mice. The oxygen tension in the spleen of mice breathing 10%, 7%, or 4.6% oxygen decreased to 36%, 31%, and 10% of normal respectively. The oxygen tension in the spleens of mice administered 10% oxygen for 10 minutes and subsequently measured while breathing 10%, 7%, or 4.6% oxygen were 26%, 22%, and 12% of normal respectively. The oxygen tension in the mice given prior treatment with 10% oxygen reached slightly lower levels. (auth)

21996 (NP-14779(p.70-88)) PHARMACOLOGICAL OR TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. IV. EFFECTS OF ACUTE AND CHRONIC EXPOSURE TO HYPERBARIC OXYGEN ON THE SURVIVAL OF NORMAL AND X-IRRADIATED ANIMALS. John Doull, Eric L. Simmons, Vivian J. Plzak, and Edna L. Marks (Chicago Univ., Ill. Air Force Radiation Lab.).

The effect of hyperoxia and hypoxia on acute radiation lethality was investigated in CF_1 female mice by exposing groups of animals to x ray doses in the range of 400 R through 800 R while maintaining the animals at environmental conditions of $1/10$ atmosphere of oxygen through 7 atmospheres of oxygen (absolute). Using the x ray LD_{50} (30 days) as the basis for comparison, irradiation at high oxygen pressure (up to 90 psig) did not markedly increase radiation susceptibility in mice. The ability of various strains of mice and of rats and rabbits to withstand chronic exposure to high oxygen pressure was investigated using a variety of pressure and exposure duration treatments. Results indicated that male and female mice and rats can tolerate prolonged exposure (over 60 days) to hyperbaric oxygen when the exposure is given in a treatment cycle consisting of 2 hours of oxygen at 15 psig followed by 1 hour of air at 0 psig which is repeated eight times per day. Increasing the duration of the oxygen exposure or decreasing the air exposure interval results in the production of mortality during the first week of exposure. Young animals

appeared to be more resistant to the toxic effects of chronic hyperbaric exposure than older animals and this effect does not appear to be related to the differences in body size and weight. Male and female animals exhibited similar symptoms of oxygen toxicity (hind leg paralysis, hemolytic anemia, loss in body weight, etc.) when chronically exposed to hyperbaric oxygen. (auth)

21997 INHIBITION OF SKIN PENETRATION OF RADIOSTRONTIUM IN MICE BY AQUEOUS FATTY-ACID GELS. Kai Setaelae (Univ. of Helsinki). Acta Radiol., Therapy, Phys. Biol., (N.S.), 3: 48-65(Feb. 1965).

The percutaneous entry of radiostrontium and protective effect of an aqueous sodium oleate gel (SOG) against radiostrontium ($^{85}Sr + ^{89}Sr$) were studied in mice by quantitative measurements of β and γ radiation as well as by autoradiography. All the carrier substances used caused a high penetration rate of $^{85}Sr + ^{89}Sr$ into the skin but its treatment with SOG decreased the degree of penetration highly significantly ($P < 0.001$). The results obtained by the measurements and autoradiography agreed. (auth)

21998 PROTECTION AGAINST IONIZING IRRADIATION BY CARBAMYL PYRAZOLE COMPOUNDS. John M. Knox, Robert G. Freeman, and Douglas Troll (Baylor Univ., Houston, Tex.). Acta Radiol., Therapy, Phys., Biol. (N.S.), 3: 66-70(Feb. 1965).

The protective effect of a new experimental compound (3, 5-demethyl-1-dimethyl carbamyl pyrazole) against ionizing irradiation was demonstrated using the endpoint of LD 100 for 30 days with a strain of albino mice. The protective effect of 200 mg/kg bodyweight was slightly less than that of 400 mg/kg which provided a survival rate of 50%. This new class of compounds shows promise and justifies further investigation to determine fully the protective effect of these and similar compounds. (auth)

21999 A COMPARATIVE STUDY OF THE PROTECTIVE ACTION OF THE TETRACYCLINE GROUP OF ANTIBIOTICS AND STREPTOMYCIN IN EXPERIMENTAL RADIATION SICKNESS. A. M. Dumova (Scientific Research Inst. of Antibiotics, Leningrad). Antibiotiki, 9: 624-7 (1964).

The radioprotective action of tetracycline, oxytetracycline, and streptomycin therapy administered 3 to 30 days prior to irradiation was compared. Groups of experimental white rats were administered tetracycline or oxytetracycline or oxytetracycline per os (300 mg/kg dose, 0.5 ml volume) or streptomycin intramuscularly (2500 unit dose, 0.1 ml volume) twice daily for 14 days and then were x irradiated with a single 750 R dose 3, 5, 10, 15, and 30 days after last treatment. Weight, activity, and appetite of animals were checked every 3 days following irradiation. Adrenal glands, spleen, and other pathological changes were investigated after animal death. Surviving animals were killed from 35 to 40 days following irradiation. Findings show that tetracycline therapy ending 3 to 15 days and even 30 days prior to irradiation is radioprotective. However, oxytetracycline is radioprotective only when the last dose is administered within 3 days prior to irradiation. Streptomycin displayed no radioprotective effect. The action of tetracycline in reducing the mortality rate in radiation sickness cannot be attributed to its antibacterial effect because the antibiotic was no longer circulating in the organism after 30 days. Possibly tetracycline increases the resistance of the organism, but the mechanism is not known at this time. (CFSTI)

22000 REDUCTION OF THE TOXICITY OF "RADIOMIMETIC" ALKYLATING AGENTS IN RATS BY THIOL PRE-TREATMENT. IV. PROTECTION AGAINST BONE MARROW DAMAGE. T. A. Connors, J. A. Double, L. A. Elson, and A. Jeney, Jr. (Royal Cancer Hospital, London). Biochem. Pharmacol., 14: 569-77(Apr. 1965).

The nucleic acids, nucleotide, and protein levels in rat bone marrow were followed after the administration of the aromatic nitrogen mustard Merophan alone and with cystein pre-treatment. The DNA dose response curve was similar to the mortality curve, which suggests that the DNA concentration of the bone marrow can be used as a sensitive index of toxicity. Based on this index the dose reduction factor for bone marrow toxicity given by cysteine pre-treatment agreed with that for whole body protection. A direct relationship was found between the rise in free SH in the bone marrow after administration of various doses of cysteine and the protection afforded to this tissue. The mechanism of the protective action thus appears to be that of an intracellular reaction between a thiol and the nitrogen mustard. (auth)

22001 PERIPHERAL LEUKOCYTE INFUSION INTO LETHALLY IRRADIATED GUINEA PIGS. Theodore I. Malinin, Vernon P. Perry, Carey C. Kerby, and Michael F. Dolan (Naval Medical School, Bethesda, Md.). Blood, 25: 693-702(May 1965).

Homologous peripheral blood leukocytes were injected into lethally irradiated guinea pigs. Histologic examination of these showed a rapid recovery of the bone marrow and the lymphatic tissue following an injection of a sufficient number of leukocytes. All control animals died with a hypoplastic bone marrow. Protected animals did not develop secondary disease during 9 months of observation. (auth)

22002 THE EFFECT OF CYSTEAMINE ON THE RESPONSES TO BIOLOGICALLY ACTIVE SUBSTANCES OF THE ISOLATED GUINEA-PIG ILEUM TAKEN FROM NORMAL AND GAMMA-IRRADIATED ANIMALS. S. Stepanovic, V. Varagic, and S. Hajdukovic. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 163-74(July 1963).

The effects of cysteamine on the responses to 5-hydroxytryptamine, acetylcholine, nicotine, and histamine of the isolated guinea pig ileum taken from normal and gamma-irradiated animals are described. The animals received 300 R from a ^{60}Co source. The intestines were taken from animals 24 and 48 hr, and 5 and 8 days after irradiation. (auth)

22003 PERSISTENCE OF ACQUIRED TOLERANCE IN CELLS TRANSFERRED TO AN ANTIGEN-FREE ENVIRONMENT. Peter Stastny (Univ. of Texas, Dallas). J. Immunol., 92: 626-9(Apr. 1964).

These experiments were designed to determine whether removal of tolerant cells to an antigen-free environment would lead to a rapid loss of tolerance. To free them of excess antigen, tolerant rat lymphoid cells were taken from the original host in which tolerance had been induced and transplanted into an irradiated recipient. Rats of the inbred Fischer strain were made tolerant by neonatal injection of sheep erythrocytes intraperitoneally. Ten-week-old normal rats of the same strain were given 1000 R of x irradiation at a rate in air of 100 R/min. Survival of the irradiated rats was accomplished by giving normal isologous bone marrow cells. Rats considered tolerant on the basis of the absence of antibody response at 10 weeks of age were used as donors of lymph node and spleen cells to the irradiated recipients. Growth of lymphoid cells in these recipients, which were presumably free of antigen, did not result in termination of the tolerant state during a period of up to six weeks before initial challenge with antigen. Antibody response to another antigen was normal. The state of tolerance induced in the donor animals was not permanent, as demonstrated by antibody production after six months in the tolerant donor controls. At this time, however, irradiated recipients of tolerant lymph node and spleen cells remained tolerant. The failure of lymphoid cells from spleen and lymph nodes to lose tolerance more rapidly in the absence of antigen suggests that other factors may be required for this change. One possibility is that immunologically competent cells produced in other tissues are involved in the recovery from the tolerant state. (BBB)

22004 THERAPEUTIC EFFICACY OF THE "REGENERATING" BONE MARROW TRANSFUSION IN ACUTE RADIATION SICKNESS. G. D. Baisogolov and K. N. Klyzhuk. Med. Radiol., 10: No. 3, 26-30(Mar. 1965). (In Russian)

Studies were made on Wistar lineage rats irradiated with a dose of 1000 R. The inquiry covered therapeutic effects

of a transplantation involving three doses of bone marrow cells (5.10^6, 1.10^7, and 5.10^7), intensively regenerating following a massive hemorrhage or sublethal irradiation. Under consideration were the 30-day survival rate and mean life expectancy. The bone marrow regenerating after bloodletting was found to increase somewhat the survival of rat-recipients. Bone marrow taken from donors 10–15 days following bloodletting proved most effective. The therapeutic use of bone marrow obtained from irradiated donors not only failed to reduce the survival of recipients, but was even instrumental in somewhat augmenting it. (auth)

22005 CALCULATING RADIATION PROTECTION FOR ACCELERATORS WITH MAXIMUM ELECTRON ENERGY OF UP TO 30 Mev. I. P. Korenkov. Med. Radiol., 10: No. 3, 39-44(Mar. 1965). (In Russian)

A procedure used in calculating radiation protection against electron accelerators with maximum energy of accelerated electrons reaching 30 Mev is described. The accuracy of the procedure was verified by dosimetric investigations. (auth)

22006 SPARSOMYCIN MODIFICATION OF THE LETHAL ACTION OF IONIZING IRRADIATION ON ESCHERICHIA COLI. Robert F. Pittillo, Mary Lucas, Carolyn Woolley, Robert T. Blackwell, and Carolyn Moncrief (Southern Research Inst., Birmingham, Ala.). Nature, 205: 773-6(Feb. 20, 1965).

The potentiating effects of sparsomycin against the lethal action of gamma irradiation on non-proliferating cell suspensions of E. coli were investigated. The antibiotic sparsomycin demonstrated slight irradiation-protecting activity at low concentrations (10 μg/ml) and marked irradiation-potentiating activity at higher concentrations (100 μg/ml) in several strains of non-proliferating E. coli. However, sparsomycin must be present during the irradiation period in order for the potentiating effect to be demonstrated. Preliminary data are given that suggest that sparsomycin in the presence of cysteine on irradiation yields a material toxic for irradiated E. coli. The radiation modifying effect of sparsomycin was not observed in rapidly dividing E. coli. (P.C.H.)

22007 RADIATION PROTECTION BY AN AUXIN ANALOGUE, β-2,4,5-TRICHLOROPHENOXYETHANOL, IN C57BL/6J MICE EXPOSED TO COBALT-60 GAMMA RADIATION. Robert D. Schultz, C. William Steers, and David Norman (North American Aviation, Inc., Downey, Calif.). Nature, 206: 207-8(Apr. 10, 1965).

A 150 mg/kg dose of the auxin analog β-2,4,5-trichlorophenoxyethanol (2,4,5-TOH) administered to mice shortly before exposure to 860 R of ^{60}Co γ radiation had a marked protective effect. The 2,4,5-TOH treated animals all lived for at least 15 days and 75% were apparently given absolute protection as they were alive 180 days after irradiation. Pseudomonas-free mice showed greater protective effects of 2,4,5-TOH than did Pseudomonas-infected mice. Possible mechanisms involved in the protective effects of 2,4,5-TOH are discussed. (C.H.)

22008 THE THERAPEUTIC EFFECT OF SPLENECTOMY IN THE WHOLE-BODY IRRADIATED DOG. H.-A. Ladner, H. H. Fruenagel, and C.-H. Schweikert (Universitat, Freiburg i. B.). Naturwissenschaften, 52: 62-3 (1965). (In German)

Dogs were exposed to 400 R whole-body x irradiation, and splenectomies were performed at various times. The survival 30 days after the irradiation showed a therapeutic effect for splenectomies performed 1 and 24 hrs after irradiation. (J.S.R.)

22009 TRANSFUSION THERAPY OF IRRADIATION DAMAGES. V. Sachs (Universitat, Kiel). Nucl. Energy, 115-19(Apr. 1965).

The use of blood transfusions in the treatment of radiation injuries is reviewed. The possibilities of therapy with corpuscular and plasmatic blood components are discussed. (C.H.)

22010 PROTECTION INDUCED BY BACTERIAL ENDOTOXIN AGAINST WHOLE-BODY X-IRRADIATION IN GERMFREE AND CONVENTIONAL MICE. G. David Ledney and Raphael Wilson (Univ. of Notre Dame, Ind.). Proc. Soc. Exptl. Biol. Med., 118: 1062-5(Apr. 1965).

When conventional and germ-free mice are administered 10 μg of E. coli endotoxin intraperitoneally 24 hours prior to whole-body x irradiation, the $LD_{50(30)}$ x ray dose is raised to about the same degree for both groups: from 739 R to 829 R for conventional mice and 834 R to 942 R for germ-free mice. For both groups the x ray dose-reduction factors lie in the narrow range of 1.13 to 1.15. (auth)

22011 RELATIONSHIP BETWEEN ANOXIA AND BONE MARROW GRAFT IN WHOLLY IRRADIATED MICE. G. Mazzella (Centro di Studi e Ricerche di Medicina Aeronautica e Spaziale, Rome). Riv. Med. Aeron. Spaziale, 27: 193-7(Apr.-June 1964). (In Italian)

A series of experiments are reported which deal with the effects of anoxia on the growth of bone marrow transplants in mice totally irradiated with various ionizing radiations. Anoxia produced the following results: increases in reticulocytes and leukocytes; protection from radiation damage, but with no retention of immunizing powers; a high percentage of survival in the animals; and better growth of the bone marrow transplant, and for a longer time. (Aerospace Med., 36: Feb. 1965)

22012 RECOVERY EFFECTS OF HOMOLOGOUS LIVER DEOXYRIBONUCLEIC ACID INJECTED INTO TOTAL-BODY IRRADIATED (600 R) INFANTILE RATS. N. Savkovic and A. Becarevic (Boris Kidric Inst. for Nuclear Sciences, Belgrade). Strahlentherapie, 126: 465-7(Mar. 1965).

The data presented show that injection of liver DNA into 8 or 17 day old irradiated rats can reduce the effect of irradiation by a factor of about 2.50. (tr-auth)

22013 SYNTHESIS AND METABOLISM OF SOME POTENTIAL ANTIRADIATION COMPOUNDS. Hemchandra Purushottam Tipnis. Thesis, Lincoln, Neb., Univ. of Nebraska, 1964. 68p.

The synthesis of 2-substituted derivatives of thiazolidine carboxylic acid was tried by condensing cysteine with various ketones. While the simple aliphatic and alicyclic ketones condensed readily, branched chain aliphatic and aromatic ketones failed to condense. The metabolism of 2,2-dimethylthiazolidine carboxylic acid was studied with ^{35}S-labeled compound. A study of the chromatograms of the urine samples of the rats receiving this compound showed that this compound breaks down to cysteine. Studies of the ionization constants of these compounds also indicated that they broke down to cysteine in aqueous solutions. The studies with ^{35}S-thiazolidine carboxylic acid further showed that the excretion in urine was rapid while that in feces was very gradual, involving excretion of twenty percent of the dose during a five day experimental period. The radioactive compound appeared very rapidly in the plasma of mice, almost within an hour after its intraperitoneal administration, and seemed to be firmly bound to plasma proteins as shown by the relatively uniform concentration maintained for more than 12 hours. Scanning of the electrophoretic strips on which radioactive plasma samples were spotted further showed that the globulin fraction of the plasma proteins bound the drug more than did the albumin fraction. Further implications of this finding will be of interest, in view of the fact that the ionizing radiations damage the globulin fraction more than the albumin fraction, and thus impair the mechanisms of an organism that resist infection. (A.G.W.)

Radiation Hazards and Protection

See also **HEALTH AND SAFETY.**

22014 (HW-SA-3338) ENVIRONMENTAL EVALUATION OF AN ACUTE RELEASE OF I-131 TO THE ATMOSPHERE. J. K. Soldat (General Electric Co., Richland, Wash. Han-

ford Atomic Products Operation). June 10, 1964. Contract AT(45-1)-1350. 19p. (CONF-642-29). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Health Physics Society, Cincinnati, June 1964.

The inadvertent release of 60 curies of ^{131}I from a Hanford Separations plant stack occurred in September, 1963. Plant operations were shutdown as soon as the abnormal release was detected, and a comprehensive program of environmental surveillance was undertaken to define the extent and magnitude of the ^{131}I deposition. Initial sampling efforts were guided by rapid calculations of the probable region of maximum deposition made by plant meteorologists. The results of the initial data collected allowed a more precise definition of the area of maximum ^{131}I deposition and the location of the individual who probably received the maximum thyroid radiation dose resulting from the accidental ^{131}I release. This individual was a child residing at the small farm where the maximum ^{131}I concentrations in milk were measured. The estimated maximum total thyroid dose to this child of 0.035 rem was supported by direct measurement of the thyroid burden made in the Hanford Whole Body Monitor. For comparison, the Radiation Protection Guide published by the Federal Radiation Council for individuals is 1.5 rem per year to the thyroid. The results of the surveillance program also supported previously derived parameters for the behavior of ^{131}I in various media in the Hanford environs and provided guidance for rapid evaluation of future accidental releases. (auth)

22015 NATURAL AND CIVILIZING RADIATION EXPOSURE FOR HUMANS. J. Meissner (Institut fur Experimentelle Biologie und Medizin, Borstel, Ger.). Atomkernenergie, 10: 75-9(Jan.-Feb. 1965). (In German)

Some experimental results on radiation doses to humans from natural and artifical sources are presented. The different components of natural background radiation are discussed in relation to standard doses for occurrence of radiation damage, based on results of radiobiological studies, and to maximum permissible dose levels for persons exposed in their professions. Relatively large local and regional variations in natural dose levels are noted. The contribution of atomic explosions is discussed. (D.C.W.)

22016 DOSE AND RELATIVE BIOLOGICAL EFFECTIVENESS OF IONIZING RADIATION. H. H. Eisenlohr and R. G. Jaeger (Johann Gutenberg Universitat, Mainz). Atompraxis, 11: 80-4(Feb. 1965). (In German)

The concept of physical dose is discussed. The usual definition of RBE (relative biological effectiveness) is given and critically discussed by means of a general expression for the dose-effect relationship. It is shown that RBE generally depends on the dose. Reference is made to attempts to obtain an interpretation of RBE in physical terms, using LET as well as a change in the dose concept. It was concluded that a physical theory of RBE cannot be expected. Rossi's work dealing with the experimental determination of microscopic dose distribution is described. (auth)

22017 A CONTRIBUTION TO THE DOSE CALCULATION IN IRRADIATING LUNGS WITH RADIOACTIVE PARTICLES. A. V. Bykhovskii and O. M. Zaraev. Med. Radiol., 10: No. 3, 31-9(Mar. 1965). (In Russian)

A procedure for calculating the pulmonary tissue local irradiation dose is described in instances when radioactive particles with varying isotope composition become retained in the lungs. Dose function values for radioisotopes most frequently making part of hot aerosol particles are given. Values of maximally absorbed radiation doses in cases of a prolonged fixation of radioactive particles in the pulmonary tissue and at different distances are estimated and charts demonstrating relation between the magnitude of the dose and factual period of the particle fixation are attached. As seen from calculations, at distances of 10 and 50 μ from the hot particle displaying activity of an order of 10^{-9}C, containing $^{95}Zr + {}^{95}Nb$, ^{103}Rn, and $^{144}Ce + {}^{144}Pr$, with the fixation time of 10 days, the radiation doses are of an order of 10^5 and 10^3 Rad respectively. The described calculation technique may be used in appreciating the results of experiments conducted on animals for studying biological hazards of hot particles. (auth)

Radiotherapy and Radiodiagnosis

Refer also to abstracts 22642, 22729, and 22761.

22018 (BNL-8165) BIOLOGICAL APPLICATION OF NEUTRON RADIOGRAPHY. Harold L. Atkins (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 27p. (CONF-778-7). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Metals/Materials Congress, Philadelphia, Oct. 1964.

The application of neutron radiography to biology is possible because of the radiographic contrast provided by the hydrogen content of living materials, and the use of high capture cross-section elements as contrast agents. Hydrogen-rich substances such as lipids, present to a greater extent in some tissues than in others (e.g., in certain areas of the brain), have low x-ray opacity but possess a high scattering cross-section for neutrons. The range of opacity of contrast agents is greater in neutron radiography, since absorption coefficients for thermal neutrons vary over several orders of magnitude, whereas the range is much narrower for x-ray absorption. Living materials have such a high hydrogen content that scattering constitutes a serious problem and causes degradation of contrast in specimens more than 2 cm thick. Two approaches to counter this effect include the use of a grid similar to roentgenographic grids, and the use of epithermal neutrons and resonance detectors. (auth)

22019 (UCLA-12-541(p.51-91)) NUCLEAR MEDICINE. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Techniques are described for performing liver, and spleen, and lung scans using suspensions of colloidal ^{198}Au or ^{131}I-serum albumin as tracers. Applications in investigations of the role of the reticuloendothelial system in diseases of the liver, spleen, and lungs and in the diagnosis and management of hepatobiliary diseases are discussed. A dual tracer technique is described for measing arterial and venous subdivisions of the pulmonary circulation separately by registering an ^{125}I lung dilution curve simultaneously with ^{131}I radiocardiogram. Diagnostic uses are reported. Results are reported from studies of the immunogenicity of a γ irradiated Brucella melitensis vaccine in mice; the use of a plastic adhesive in the surgical management of intracranial aneurysms and leaking cerebral vessels in man; the use of ^{51}Cr-erythrocytes in studies on the fate of blood in the subarachnoid space following rupture of an intracranial aneurysm; the use of radioisotope cerebrogram, hypothermia, and arterial by-pass in resection of an arteriosclerotic aneurysm of the cervical internal carotid artery; the short-term retention of injected ^{85}Sr in man and use of the findings in estimates of initial ^{90}Sr body burdens; the growth and morphology of mouse lymphoma cells in diffusion chambers; comparative studies of the oncogenic properties of desoxyribonucleic acid from primary parotid gland tumors, passage parotid gland tumors, and polyoma virus in mice; nucleic acid transmission of leukemia in mice; the detection of bronchial obstruction by lung scanning after radioaerosol inhalation; renal blood flow studies in rabbits poisoned with $HgCl_2$; renal blood circulation; clinical applications of radioisotope procedures in a variety of renal disorders; the use of ^{51}Cr-erythrocytes and ^{131}I-albumin microaggregates to determine the efficiency of irrigation methods in removing blood from the subarachnoid space; a comparison of the distribution of ^{95}Zr and ^{95}Nb in maternal and fetal rabbit tissues; spectrophotometric studies of the mechanism of indirect action of ionizing radiation on purines and pyrimidines; the protective effects of dimethylsulfoxide against radiation injuries in mice; the evaluation of data from life span studies on

irradiated mice; the leukemogenic properties of DNA and RNA from the organs of mice with virus induced leukemia; virus-induced leukemia in irradiated mice; and the role of desoxyribonucleic acid and the thymus in leukemogenesis in mice. (C.H.)

22020 A HISTOCHEMICAL CONTRIBUTION TO THE PROBLEM OF OXYPHILIC GRANULAR CELL CARCINOMA (MALIGNANT ONCOCYTOMA) FROM X-IRRADIATED "LAMINAR TUBERCULOSIS" (SCROFULA + LUPUS VULGARIS). H. G. Goslar, W. Schneider, and W. Undeutsch (Universität, Bonn). Acta Histochem., 19: 14-24(1964). (In German)

A 70-yr-old woman who suffered from fistular lymph node tuberculosis, followed by lupus vulgaris, since the age of 24, had been treated numerous times with x ray over a period of 25 yr. She developed a tumor on the cheek that was diagnosed as a lupus x-ray sarcoma. Histological study indicated that the tumor was a malignant oncocytoma. In the past it has been reported that irradiation of lupus vulgaris may produce a combination of carcinomas and sarcomas. However, another tumor that has a less frequent incidence is malignant oncocytoma, which results from intensive irradiation of this condition. It is a tumor composed of characteristic, swollen granulated cells, which appears most frequently in the salivary glands, but may also be found in other organs. The tumor has benign and malignant forms. In contrast to the benign form, the malignant form is typified by infiltrating, destructive growth, and may also metastasize. Histochemical reactions of the tumor are described in detail by the authors. (49 references.) (BBB)

22021 IODINE 125 AS A RADIATION SOURCE WITH SPECIAL EMPHASIS ON ITS APPLICATIONS IN MEDICAL RADIOLOGY. I. THEORETICAL CONSIDERATIONS. Per Beronius, Sevald Forberg, Carl O. Henrikson, and Rune Soeremark (Royal Inst. of Tech., Stockholm; Royal School of Denistry, Stockholm; and Harvard School of Dental Medicine, Boston). Acta Radiol., Therapy, Phys., Biol. (N.S.), 3: 33-48(Feb. 1965).

Formulae are given for the intensities obtainable from both cylindrical and spherical sources constituted of any radioactive nuclide suitable for medical radiography. The intense 27.4 kev roentgen rays emitted on the disintegration of ^{125}I are discussed. The optimum source width is shown to be limited by the resolving power and exposure time requirements as well as by the cost of the radionuclide and the increased skin dose from a proximate source. (auth)

22022 DISSOCIATION OF I^{131} FROM RADIOPHARMACEUTICALS AS MEASURED BY THYROID UPTAKE. Yen Wang (Univ. of Pittsburgh). Am. J. Roentgenol., Radium Therapy Nucl. Med., 93: 962-4(Apr. 1965).

The stability of various ^{131}I labeled compounds, which are currently employed in medicine, was evaluated by ^{131}I thyroid uptake studies. Rose bengal-^{131}I and hippuran-^{131}I showed the least ^{131}I thyroid uptake and are proven to be the most stable compounds. They are ideal for clinical use. Four doses of Lugol's solution, 5 drops each, in one day were found to be satisfactory for the blockage of the thyroid in preparing the patient for a larger tracer dose of RISA and for an ^{131}I triolein study. (auth)

22023 USE OF INTRA-ARTERIAL HYDROGEN PEROXIDE TO PROMOTE WOUND HEALING. PART I. REGIONAL INTRA-ARTERIAL THERAPY-TECHNICAL SURGICAL ASPECTS. PART II. WOUND HEALING—CLINICAL ASPECTS. G. A. Balla, J. W. Finney, B. L. Aronoff, D. L. Byrd, G. J. Race, J. T. Mallams, and G. Davis (Baylor Univ. Medical Center, Dallas). Am. J. Surg., 108: 621-9(Nov. 1964).

During the earlier studies in the treatment of patients with intra-arterial hydrogen peroxide and irradiation therapy, it was found that not only did the tumor respond more rapidly to irradiation, but that the wounds healed much faster and with less scar formation. Thus, radiotherapy-induced wounds that were refractory to conventional treatment were treated with intra-arterial hydrogen peroxide either alone or in combination with intra-arterial antibiotics. Many of the major reasons for delays in wound healing (inadequate nutrition, necrotic tissue, foreign bodies, bacterial infections, interference with blood supply, lymphatic blockage, and diabetes mellitus) can be attributed to tissue anoxia. It was believed that if tissue anoxia could be altered by regional superoxygenation, increased healing could be achieved. Daily or twice daily infusions of intra-arterial H_2O_2 were given with or without intra-arterial antibiotics. Five representative cases are described showing increased wound healing in patients with cancer treated with combined intra-arterial H_2O_2 and irradiation therapy. In nine other cases intra-arterial H_2O_2, with or without intra-arterial antibiotics, was used for delayed wound healing that was unresponsive to conventional modes of therapy. Surgical technics were developed for introducing polyvinyl catheters into regional arteries for continual or intermittent intra-arterial infusion therapy. Steps were taken to prevent or eliminate the various complications that have been encountered during earlier experimental studies. Infections were largely eliminated by removing the exit site of the catheter from the point of entrance into the vessel. Clotting in the catheter is still a problem. Technics of preparing, starting, and stopping the infusion solution of H_2O_2 are presented. (BBB)

22024 THE EFFECT OF LOCAL ROENTGEN THERAPY OF MALIGNANT TUMORS ON THE GLYCIDE METABOLISM OF HUMAN ERYTHROCYTES. J. Sonka, J. Nosek, Z. Vich, J. Pospisil, and Z. Dienstbier (Charles Univ., Prague). Atompraxis, 11: 157-8(Mar. 1965).

Local x irradiation applied to patients suffering from a malignant tumor caused a decrease in the activity of the pentosephosphate cycle in their erythrocytes. This finding is discussed in connection with the significance of the pentose-phosphate cycle for the growth and regeneration of the tissues. (auth)

22025 ADJUVANT CHEMOTHERAPY (TRIETHYLENE THIOPHOSPHORAMIDE) WITH RADICAL MASTECTOMY AND RADIOTHERAPY IN BREAST CANCER. G. W. Hankins and A. B. McCarten (Univ. of Alberta, Edmonton, Can.). Can. Med. Assoc. J., 89: 1305-9(Dec. 28, 1963).

Seventy patients with breast cancer treated by operation, adjuvant triethylene thiophosphoramide (Thio-TEPA), and postoperative radiotherapy were compared with a control series of 70 patients treated by operation and radiotherapy alone, with particular emphasis on avoidance of complications. The schedule for administering the drug was as follows: 0.8 mg/kg body weight was given intravenously in four equal divided doses, the first dose being given at the time of operation and the remaining on the first, second and third postoperative days. Radiotherapy was commenced in most cases as soon after operation as possible, usually about the 20th day. Patients received irradiation to the supraclavicular fossa, apex of axilla, and parasternal chain. If the axillary nodes were positive, a moderate dose, averaging about 3400 rad, was delivered centrally to the chest wall in 15 treatments. The standard dose to the supraclavicular area was 4700 rad centrally, and to the parasternal area about 4200 rad, applied in three weeks. No incidence of excessive vomiting, stomatitis, diarrhea, or other complications attributable to the drug occurred during the immediate postoperative period. Apart from the usual percentage of patients with mild to moderate radiation sickness, no serious complications from irradiation were reported in either group. The course of postoperative radiotherapy was not interrupted unless the white blood cell count dropped below 2500 cells per mm^3. If the pretreatment white cell count was low (less than 5000), radiotherapy was continued even if the white blood cell counts dropped below 2500 per mm^3. Bone marrow depression, of which the white cell count is the most sensitive index, occurred to a moderate degree in the control series. Various reasons are given for this marrow depression, including irradiation of bone marrow, irradiation of circulating cells passing through the field, and an

unknown humoral factor. The depressant effect on the white cell count was correlated with the shortness of the period during which radiotherapy was administered. These results indicate that the additive effect of thio-TEPA and radiotherapy produces a definite and considerable depression of hematopoiesis. No serious complications such as agranulocytosis or fulminating infections were observed, and in all cases marrow regeneration occurred. Radiotherapy was not completed in only three cases and all three received over half of the planned dose. It is suggested that to avoid complications during radiotherapy, the radiotherapist, particularly during the second week of radiotherapy, must carefully assess hematologic changes. (BBB)

22026 DETERMINATION OF DOSE IN ARC THERAPY BY NUMERICAL INTEGRATION. D. Craig. Brit. J. Radiol., 38: 285-7(Apr. 1965).

It is shown that improvements in the accuracy of dose determination in arc therapy can be achieved by adopting numerical integration methods instead of direct summation. A simple integrating rule giving the most accurate results is selected, and an optimum interval size suggested. (auth)

22027 RADIATION PNEUMONITIS FOLLOWING A LOW DOSE OF COBALT TELETHERAPY. George Wiernik (St. Thomas' Hospital, London). Brit. J. Radiol., 38: 312-14(Apr. 1965).

A case history of the development of radiation pneumonitis after low dosage cobalt teletherapy for mediastinal glandular enlargement is cited. Besides low dosage, the rapidity of the development of radiological evidence of pulmonary fibrosis was especially noted. (P.C.H.)

22028 STUDIES WITH RADIOCOPPER (^{64}Cu) IN WILSON'S DISEASE: THE LIVER/THIGH RATIO. S. B. Osborn and J. M. Walshe (King's Coll. Hospital, London). Clin. Sci., 27: 319-28(Oct. 1964).

In these studies of liver uptake of Cu it was necessary to devise new techniques in accord with restrictions imposed by the use of radioactive materials in human subjects and necessitating the use of very sensitive counting equipment. In general, no more than 120 μC ^{64}Cu, given intravenously, was used in subjects suffering from, or suspected to be suffering from Wilson's disease, and as little as 50 μC in controls. It is only possible to carry out studies of ^{64}Cu in the various fractions of blood when 100 μC can be administered, but external counting of the liver radioactivity can be undertaken using such smaller quantities. To make a detailed analysis of the hepatic uptake of Cu in the immediate postinjection period the counting rate over the liver was compared with that over the thigh (liver/thigh ratio). These L/T ratios were determined at frequent intervals, or as a continuous record by a recording milliammeter, up to 15 min after injection, at 2 hr, and again at 24 hr. The values obtained on 9 control subjects showed that the L/T ratio tended to rise fairly rapidly, averaging 2.2 at 15 min with a range of variation from 1.7 to 2.4; by 4 hr it had risen further to an average of 4.8 and by 24 hr to 7.2. The corresponding ratios in three subjects heterozygous for the Wilson's disease gene were similar, 1.9 at 15 min, 5.2 at 2 hr, and 14.5 at 24 hr. In the ten patients with Wilson's disease the L/T ratio tended to fall below 1.0 and in no case did it exceed 1.2 at 15 min so that there was no overlap between the patients and the control subjects or the heterozygotes; the average at 15 min was 0.8 with a range of 0.5 to 1.2, at 2 hr it was 1.4, and at 24 hr 1.6 so that at all times up to 24 hr the patients and the control groups were mutably exclusive. Most patients with other forms of liver damage fell within the normal range, only one having a low ^{64}Cu uptake. It is concluded that the impaired ability of the liver in patients with Wilson's disease rapidly to concentrate injected Cu was not due simply to nonspecific liver injury but was part of the genetically determined disease process. In the immediate post-injection period this method did not distinguish between uptake of Cu by the liver parenchyma and the liver content of blood rich in ^{64}Cu. These studies show that determination of the L/T ratio is a quick and simple method of establishing the diagnosis of Wilson's disease and to separate homozygous abnormal subjects from heterozygotes when these come in the range of overlapping ceruloplasmin values. This is of particular value in screening close relatives of patients with proven Wilson's disease. (BBB)

22029 THYROID FUNCTION DIAGNOSIS WITH RADIOIODINE WITHOUT INCORPORATION OF THE RADIONUCLIDE. IN VITRO METHODS OF MEASUREMENT WITH ^{131}I-LABELED L-3,5,3'-TRIIODOTHYRONINE. E. H. Graul and W. Stumpf (Universität, Marburg, Ger.). Deut. Med. Wochschr., 88: 1886-91(Sept. 27, 1963). (In German)

Procedures for in vitro studies of thyroid function with radioactive triiodothyronine and thyroxine include dialysis of free and protein-bound thyroxine, which is inaccurate and difficult, electrophoretic estimation of thyroxine binding, uptake of ^{131}I-labeled triiodothyronine by red cells or iron exchangers, and gel filtration of protein-bound triiodothyronine. All of these methods have the distinct advantage that they serve a diagnostic purpose without requiring the patient to be injected with ^{131}I. The patient only furnishes the biological material, such as blood or urine, with which the test is carried out. The tests all depend on the direct or indirect measurement of the capacity of thyroid hormones to bind to serum protein to evaluate functional thyroid status. From the range of in vitro tests available, the procedures that use ion exchangers or gel filtration are probably the most advantageous. So far, they have given good, dependable results, are simple to carry out, and what is most important, avoid the administration and incorporation of ^{131}I by the patient. For these reasons they should have wide use in the future. (41 references.) (BBB)

22030 SIGNIFICANCE AND EVALUATION OF BONE MARROW FUNCTION ASSAY IN THE RADIATION TREATMENT OF MALIGNANT TUMORS. D. Schoen (Medizinische Strahleninstitut der Universitaet, Tuebingen, Ger.). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 99: 824-30 (Dec. 1963). (In German)

Patients with malignant tumors who have been treated with cytotoxic and chemotherapeutic agents frequently suffer from toxic bone marrow damage. Normal leukocyte and granulocyte counts do not exclude this type of injury. The degree of injury can be measured by the extent of leukocytic response evoked within 24 hr after administration of Pyrexal, a highly purified lipopolysaccharide obtained from Salmonella abortus equi. This response depends on the intact function of the adrenal cortex, but it is not affected by cortisone. In normal persons the maximal increases in leukocyte counts are observed within 2 to 8 hr after the drug is given, and the amplitude of the increases are between 1.24 and 3.5 times the initial value. Normally, the dose to be administered should be about 0.04 μg. Increased dosage does not alter the leukocytic response, but only produces side-effects. In tests on 208 patients the dose response curve was hyperbolic, but an exact mathematical relation has not been established. Generally, the lower the initial leukocyte count is, the greater is the response to the drug. The neutrophilic granulocyte count also increases when this drug is used. (47 references) (BBB)

22031 THE ACTIVITY OF SERUM GLUTATHIONE REDUCTASE DURING RADIATION TREATMENT OF UTERINE CARCINOMA. G. Rathgen, W. Humke, and K. Pieper (Universität, Mainz). Geburtsh. Frauenheilk., 24: 815(Sept. 1964). (In German)

According to Mazia's hypothesis the relation between oxidized and reduced glutathione should be important for the cell division cycle. In human serum an enzyme could be detected that reduced oxidized glutathione. Reduced nicotinamide adenine dinucleotide phosphate (NADPH, TPNH) is used as a H donor in this procedure, but the reaction will also take place to a lesser degree with reduced nicotinamide dinucleotide (NADH, DPNH). With the simplifying assumption that two separate glutathione reductases

with marked specificity are involved here, estimates of the activity were carried out optically at 334 mμ in two separate series with NADPH and NADH. One result obtained was that the activity of the glutathione reductase that depended on NADH was scarcely affected by irradiation. The enzyme that required NADPH reacted to an initial irradiation with 100-R focal dose by a marked loss in activity. However, after a third irradiation the original activity value was reached once again. The activity of the glutathione reductase did not change during the further course of irradiation, and the activity of both enzymes reached almost the same value. These findings indicate that radioinduced changes in glutathione concentration are not caused by alterations in activity of glutathione reductases. (BBB)

22032 ON THE SIGNIFICANCE OF LATE UROLOGICAL INJURIES IN THE TREATMENT OF UTERINE CARCINOMA. L. Moench and J. Holtorff (Medizinische Akademie Carl Gustav Carus, Dresden). Geburtsh Frauenheilk., 24: 864-81(Oct. 1964). (In German)

To assess the frequency of late urinary tract complications, follow-up examinations are reported of 257 patients who were operated on and irradiated or had radiotherapy only for uterine cancer (carcinoma of the cervix, stages I to III, or endometrial carcinoma). The patients were all considered to be cured or to be free from recurrence and were examined from one to 15 yr after treatment. In 130 cases, preoperative Ra treatment plus postoperative x-ray or ^{60}Co γ-radiation treatment had been given, including two to three 2000-mg/hr Ra doses plus 2500 to 3500 R local doses of external radiation. In 126 other patients the radiotherapy was not accompanied by surgery. Of the total 257 cases, 161 showed late changes in the bladder, which could be classified as follows: 134 cases of bladder telangiectasia, 21 of scarring, 41 rigidity of the bladder wall, 21 reduced capacity, 14 bullous edema and trigonitis, 31 submucosal bleeding, 20 inflammatory deposits of fibrin, and 13 ulceration. However, only in 14.4% of the patients were they of sufficient severity to require treatment by a specialist. Intravenous pyelograms revealed a 40% incidence of functional disturbances of the kidneys and ureters. However, only 4.4% of the cases showed advanced disease (8 unilateral hydronephroses, one unilateral nonfunctioning kidney combined with contralateral hydronephrosis) and needed immediate urologic treatment. The etiology, pathogenesis, and prognosis of late urinary complications are discussed in detail in correlation to the type of intensive therapy used. Routine urologic follow-up examinations at short intervals of all women previously subjected to operation and/or radiotherapy for uterine cancer are the only means of early diagnosis of urinary tract complications. Some hospitals do not yet have departments of urology large enough to handle the follow-up of these patients in an ideal manner. A simplified method of follow-up studies is therefore proposed which allows the early recognition of late urinary tract complications. (BBB)

22033 CHRONIC LEUKEMIA. David W. Molander and John S. LaDue (Memorial Center for Cancer and Allied Diseases, New York). Geriatrics, 19: 393-406(June 1964).

Indications for and effects of irradiation in this disease are examined in detail, with dose data provided. It is maintained here that the most effective single agent in the treatment of chronic leukemia at its onset and throughout the major course is x-ray therapy. Local irradiation is the only effective agent in reducing enlarged lymph nodes and is the most rapid, safe, and efficient method of inhibiting abnormal leukocyte production. Whole-body irradiation and radiophosphorus (^{32}P) are comparatively less effective, more difficult to administer, and their effects more difficult to control. Local x-ray therapy is also most effective in the management of massive enlargements of the spleen or liver. The spleen is best treated through an anterior and a posterior port, generally 15 by 10 cm to 20 by 15 cm in size. Factors include 250 kv; 70 cm T.S.D; 1.5 mm Cu filtration; giving 100 to 150 R daily to alternating fields. In chronic myelocytic leukemia, the total dose given two or three times over a period of one to two weeks usually varies from 300 to 600 R in air to each field. In chronic lymphocytic leukemia, a small dose achieves the desired results. The single course varies from 200 to 400 R in air in each port. Bulky lymph node masses or the liver may be similarly treated. When splenic or hepatic involvement is not obvious, the abdomen or the chest can be divided into four portals, 15 to 20 cm square, anteriorly or posteriorly, and the requisite dose delivered at a distance of 50 to 70 cm. With a voltage of 250 kv the filter is 1.5 mm Cu; with 200 kv the filter includes also 0.5 to 1.0 Al. The dosage must be individualized. For example, with a white blood cell count of 50,000 to 100,000 it is safe to give 50 R to each portal daily on two or three successive days, checking the blood count within a week of the first treatment to evaluate the efficacy of the treatment. Further therapy in the same dose, or 100 R doses if needed, is given until the white blood cell count falls to one-third of the original amount, but not below 50,000. Two-hundred R is the max dose given in one week to each portal. Therapy is stopped at the 50,000 mm^3 level of the white blood cells and should not be continued below 20,000 mm^3. Ordinarily, a further drop of white blood cells occurs after cessation of treatment, hence, it is desirable to stop the treatment at a higher level and check the blood count at weekly intervals. Symptomatic improvement usually accompanies an improved white cell count. Most patients with chronic leukemia have remissions lasting from a few weeks to several months following local irradiation of 150 to 300 R given in divided doses. Dosage to the liver, spleen, or intra-abdominal nodes should not exceed these limits, using the response of the white blood cell count as a measure of tolerance. Peripheral lymphadenopathy in the cervical, axillary, and inguinal regions, however, can be given somewhat larger single doses without seriously depressing the bone marrow. Three or four such areas may receive 100 R. Often the patient requires increasing amounts of radiation, even 1000 R or more, to produce each clinical remission until he becomes resistant to further therapy. Leukemic patients with a low initial white cell and platelet count can be treated with x-ray therapy with the expectation of improvement, but therapy must be given cautiously and in low dosage at well-space intervals, guided by blood counts taken at least twice a week. For example, 50 R can be given daily for two days, and the third day a blood count may warn of sudden, severe, irreversible depression of the marrow. Results are usually not as satisfactory in these patients, but sometimes they tolerate surprising amounts of irradiation with great benefit associated with a rise in hemoglobin or platelet count. Total-body irradiation is not widely used in the treatment of chronic leukemia. It fails to control the bulky lymphadenopathy, and its main effect is to depress the leukocyte count. The use of ^{32}P is also discussed. Advantages of this form of treatment are inherent in the physical characteristics of ^{32}P; its half-life is 14.3 days. In its disintegration, only β particles are emitted which have a max range of penetration of ~7 mm and produce ionization in tissues, without secondary radiation. When it is given by mouth, it is usually not readministered for six to eight weeks, and then only when symptoms develop. (BBB)

22034 REMOVING ELECTRON CONTAMINATION FROM A CESIUM-137 GAMMA BEAM WITH MAGNETIC FIELD. Hiroshi Yamaguchi (Hitachi, Ltd., Tokyo). Hitachi Hyoron, 46: No. 9, 78-83(Sept. 1964). (In Japanese)

In order to eliminate the secondary electron radiation injury in ^{137}Cs radiotherapy, the electrons were removed by deflection in a magnetic field (700 to 1100 gauss). The method was found to be more effective than the usual methods. (NSA of Japan)

22035 THE BEHAVIOR OF GLIOMAS IN TISSUE CULTURE. III. COMPARATIVE STUDIES ON GLIOMAS IRRADIATED IN VIVO. Laszlo Zoltan, Iren Palyi, and Denes Afra (Orszagos Idegsebeszeti Tudomanyos Intezet, Budapest). Ideggyogy. Szemle, 16: 193-8(July 1963). (In Hungarian)

The case histories of four patients who underwent sur-

gery for removal of gliomas, which were studied histopathologically, are described. Tissue cultures were also prepared. The patients received large doses of x radiation and were reoperated after 1 yr, the tumors again being studied histopathologically. The tissue cultures were examined weekly. Irradiation of the patients was conducted daily with 180-kv x rays, via two ports at 150 R each. Total doses ranged from 17,000 to 18,000 R in three patients, the fourth patient received no irradiation. Two of the patients were diagnosed to have glioblastoma multiforme, one malignant astrocytoma, and one a mixed type of astrocytoma; this patient received no irradiation and the growth showed a more malignant form after reoperation. The tissue culture in this instance showed a malignant astrocytoma type growth. It was found, in general, that the tumors in the irradiated patients showed no pathological changes; the infiltrative development remained the same after irradiation. The tumor cells in tissue cultures showed a decrease in growth and a marked degeneration of the cells in the third week. The decrease in biological activity of the tumor cells was attributed to irradiation. The decreased viability of the irradiated tumor tissue in cultures and the malignant development of the nonirradiated tumor as seen in later cultures supports the assumption that irradiation tends to inhibit rather than further the growth of gliomas. (TCO)

22036 JAPANESE THYROID UPTAKE SURVEY. H. Kakehi, N. Arimizu, K. Saegusa, and I. Watanabe (Chiba Univ., Japan). Intern. J. Appl. Radiation Isotopes, 15: 641-54(Nov. 1964).

During 1961, about 30,000 radioisotope tests were recorded in 127 hospitals in Japan. About 84% of the radioisotope usage was with iodine-131 related to thyroid diseases. Throughout Japan various instruments, formulas, standard sources, and distances were used. This variability of measurement technique was known to cause considerable error. A thyroid uptake survey was carried out in the hospitals of Kanto, Kansai, Hokuriku, Tohoku, and Kyushu districts during the years 1959–1961. The survey was done to assess the magnitude of error, to determine the causes of error, and as a training procedure. The use of an acceptable neck phantom and proper filters had an important role in correcting the results of the measurements. Data are tabulated. (P.C.H.)

22037 EXPERIMENTAL COMPARISON OF DOSIMETRIC DATA FOR YTTRIUM OXIDE (Y^{90}) RODS. M. S. Elmanharawy (Hammersmith Hospital, London). Intern. J. Appl. Radiation Isotopes, 16: 217-20(Apr. 1965).

Calibration factors, depth-dose curves and isodose contours have been obtained for ^{90}Y oxide rods of different lengths and diameters. The results are compared with those published by Jones et al. for ^{90}Y rods of 1 mm diameter. (auth)

22038 COMPARISON OF RADIOACTIVE IODINATED SERUM ALBUMIN (RISA) AND RADIOACTIVE MERCURY^{203} FOR BRAIN SCANNING. William Feindel, Y. Lucas Yamamoto, and Nicholas Rumin (Montreal Neurological Inst.). J. Neurosurg., 21: 1-6(Jan. 1964).

Advantages and disadvantages of these two substances for detection of brain lesions are contrasted, and a comparative study was made of their use in patients with cerebral tumors. RISA is readily available, less costly, and more familiar, but it has two properties that limit its value. First, in addition to the main emission of γ rays at 360 kev (87%), ^{131}I emits higher energy γ rays at 640 kev (9%) and 720 kev (3%). This makes shielding of scattered radiation difficult. Moreover, this high-energy γ radiation is scattered and reduced in energy as it passes through the tissues of the head, resulting in less efficient resolution. Secondly, RISA is eliminated slowly from the body, which obscures the activity of the target by background radiation. Neohydrin-^{203}Hg is characterized by a physical half-life of 45.8 days; a single-line γ emission eliminates the foreign counts coming from the scattered high-energy levels associated with RISA. The lower energy of γ radiation at 280 kev simplifies the problem of shielding. In addition, the more rapid clearance of this compound from the body, partly because of its diuretic properties, favors an increase of the target-to-background ratio, and permits earlier scanning. The dose of radiation to the whole body from radio-Neohydrin is about 50% less than that from the amount of RISA commonly employed for brain scanning. One detraction from the value of this agent, however, is the selective dosage of radiation to the kidney, but this can be reduced by a blocking dose of nonradioactive Neohydrin. Double isotopic studies were made in a selected series of verified tumors; the patients were first scanned using radio-Neohydrin and then with RISA. The results indicated clearly that Neohydrin-^{203}Hg gives earlier and higher local uptakes as compared to RISA. Radio-Neohydrin was injected in the dosage of 10 μC/kg of body weight. The patients were scanned immediately and again at 3- and 6-hr intervals. Scans with RISA were made several days later. The injection of 300 to 400 μC of RISA was preceded by Lugol's iodine solution, and scans were made immediately and at 24- and 48-hr intervals. In patients with meningiomas or glioblastoma multiforme, Neohydrin-^{203}Hg gave a differential uptake over the tumor of double that obtained with RISA. Triple scans after a single injection of radio-Neohydrin showed that the optimal time for scanning with this agent is about 3 hr. A further double tracer study in 15 patients with verified gliomas, metastatic neoplasms, subdural hematomas, and infarcts showed that Neohydrin-^{197}Hg gives uptakes as early and as high as Neohydrin-^{203}Hg, with the advantage that the calculated dosage of radiation to the kidney is reduced to a very low level, less than 1% of that from ^{203}Hg. (BBB)

22039 THE UTILIZATION OF ^{99m}TECHNETIUM IN BRAIN SCANNING. Richard Witcofski, Douglas Maynard, and I. Meschan (Bowman Gray School of Medicine, Winston-Salem, N. C.). J. Nucl. Med., 6; 121-30(1965).

The clinical usefulness of ^{99m}Tc in brain scanning is discussed. In this series of 142 patients, examples of positive scans are presented in patients with known pathology. Comparison is made to other brain scanning agents currently being utilized. (auth)

22040 COBALTHERAPY IN VESICAL TUMORS. F. Leguevaque, A. Lhez, and P. Marques (Hospital La Grave, Toulouse). J. Radiol., Electrol. Med. Nucl., 45: 789-95 (Dec. 1964). (In French)

From their experience concerning 115 patients with vesical tumors treated with telecobalt therapy, the authors conclude that good tolerance was manifested by the patients towards this method of therapy. When a strict medical and urologic check-up was made, a small number of bladder (less than 5%) and functional renal disorders were noted. After precise centering, doses limited to 5,000 rads, distributed in 25 sessions during four to five weeks were used. The value of telecobalt therapy during various stages of tumor growth and the relative merits of surgery and telecobalt therapy in some cases are discussed. (C.H.)

22041 INFLUENCE OF PREVIOUS SURGERY ON RESULTS OF MEGAVOLTAGE RADIOTHERAPY IN CARCINOMA OF BLADDER. C. D. Collins (St. Thomas's Hospital, London). Lancet, 2: 988-90(Nov. 7, 1964).

Radiation reactions in 105 patients with carcinoma of the bladder treated by radical megavoltage radiotherapy are described, and the effectiveness of radiotherapy as the primary method of treatment is compared with that of radiotherapy following previous surgery. The maximum tumor dose varied from 5000 to 6000 R given over a period of four to five weeks. Most patients were treated three times a week, or on a time/dose scheme calculated to give a similar radiobiological effect. Most patients developed diarrhea during treatment, but this lasted for no more than two to three weeks, and there were no major rectal complications. Two patients died from small-bowel complications: one from an attack of acute enteritis shortly after the completion of treatment, and the other from a perforated small bowel 18 months after irradiation. In both, the bladder was free of tumor at postmortem examination, and these deaths followed the use of higher doses than

usual. In practically all patients urination frequency and urgency increased towards the end of treatment, but in none did these symptoms persist for more than a month; nor did hematuria return in the absence of resistant or recurrent tumor, except in one patient who developed radiation cystitis. Here again a higher dose than normal was given. Those patients treated by only one fulguration or perurethral resection, and who were irradiated shortly afterwards, responded in a similar way to those treated by radiotherapy in the first instance. It is postulated that in the former there was neither sufficient time nor severe enough trauma to materially alter the blood supply, and for fibrosis to occur. Some patients in whom the tumor appeared to be radioresistant successfully underwent subsequent operation. In some this may have been carried out unnecessarily, either before full regression of the tumor after radiotherapy, or without histological evidence of residual tumor. Therefore, it is suggested that as little surgery as possible should be carried out after radical radiotherapy; and no major surgical procedure should be undertaken before six months, unless the tumor is seen on repeated cystoscopy to be unaltered or growing rapidly, and then only after a positive biopsy. (BBB)

22042 SIGNIFICANCE OF THE PROFILE SCANNING TECHNIQUE IN DIAGNOSING MALIGNANT THYROID NEOPLASMS. V. Z. Agranat and N. V. Obukhova. Med. Radiol., 10: No. 3, 7-11(Mar. 1965). (In Russian)

The importance of an investigative procedure involving the use of radioisotopes, the profile scanning technique with the aid of a slit collimator, is discussed. This examination precedes planar scanning, takes little time, and thus permits it to repeat the procedure many times over at different intervals, and helps to choose the area to be submitted to planar scanning. The technique is helpful in choosing optimal conditions for planar scanning. Its systematic use at definite time intervals makes it possible to register accumulation of ^{131}I and the rate at which it is eliminated from the body and the thyroid gland. (auth)

22043 RADIATION TREATMENT OF PATIENTS WITH CHRONIC MYELOID LEUKEMIA. V. F. Krutenko. Med. Radiol., 10: No. 3, 21-6(Mar. 1965). (In Russian)

Results following treatment of 206 patients affected with chronic myeloid leukemia implicating utilization of different radiation sources and methods of irradiation (local and general x rays, gamma irradiation of the spleen with the aid of radium, ^{32}P therapy) are discussed. The ^{32}P therapy presented no advantages over x irradiation, when applied to patients with marked leukemia symptoms. In studying accumulation and distribution of ^{32}P in body organs and in the blood this was found to be scattered nonuniformly throughout the body, in the first hours being absorbed from the gastrointestinal tract into the blood and then showing maximal aggregation in the liver and spleen, a fact that corroborates the adequacy of procedures employed for external and internal irradiation of the said organs. Radiation treatment makes it possible to considerably lengthen the active life of a patient, without, however, increasing appreciably the total duration of his life. (auth)

22044 THE PRACTITIONER AND RADIOISOTOPES. V. HOW THE PHYSICIAN CAN PROCURE RADIOISOTOPES AND HOW HE SHOULD HANDLE THEM. B. Bellion (Universita, Turin). Minerva Med., 54: 2784-90 (Sept. 1, 1963). (In Italian)

Any physician in Italy who wishes to use radioisotopes must apply to the local civil authorities stating the physical, chemical, and biological type of radioactive material wanted. This permit is issued by the Provincial Health Officer and conforms to EURATOM specifications. Material with radioactivity below 0.1 μC and radioactive drugs which have a concentration below 0.002 μC per g do not require authorization. A table lists various radioisotopes giving their half-life period and energy emitted as β particles and γ radiation. The principal diagnostic uses of ^{131}I and ^{32}P isotopes are listed, as well as the therapeutic uses of ^{131}I, ^{32}P, and ^{198}Au. Packing of radioisotopes must conform to specifications of the International Atomic Energy Agency. Handling radioisotopes in the clinical lab is discussed. Withdrawal of isotopes from the container should be performed through remote control. The biophysical lab should be divided into four areas, with an entry zone where the weekly radiation dose is below 0.03 rem. In a second zone, entry is reserved to personnel without special clothing where weekly radiation is below 0.1 rem/week. In a third area, where entry is reserved to personnel equipped with special clothing and footwear, the weekly radiation is 0.1 rem, and there is danger of contamination. In the fourth zone, entry is reserved to personnel with special clothing because there is an elevated level of radiation and contamination. Protective clothing is discussed in terms of normal clothing and special clothing. Normal clothing includes lab smocks, overalls, aprons, rubber gloves, and footwear. Special clothing comprises complete protective suits, water-repellent suits, diving apparatus, and breathing equipment. Ventilation systems, shielded work areas, glove boxes, and remote control equipment used in Italian nuclear research installations are described and illustrated. (BBB)

22045 RADIATION MICROSPHERES IN EXPERIMENTAL AND HUMAN MALIGNANCIES. Y. S. Kim, J. W. La Fave, L. D. MacLean, and J. F. Perry, Jr. (Veterans Administration Hospital, Madison, Wis.). Minerva Nucl., 8: 137-9(Mar.-Apr. 1964).

A method was designed to deliver a cancerocidal dose of radioisotope-laden microspheres via the nutrient blood vessel to a tumor. The spheres lodge in the precapillary bed of the area, and a prolonged radiation treatment may be accomplished without danger of systematic effects. Yttrium-90, an energetic β emitter (0.93 Mev), with a half-life of 2.66 days, fulfilled the desired requirements. Ceramic microspheres have several unique advantages: they are of uniform size and too large to pass through any capillary bed, capable of carrying a wide variety of cationic isotopes in sp act. up to 10^4 C/g, and have great stability of sphere itself and of the isotope within the sphere. Distribution of spheres in dog lung and liver was studied. Consistently satisfactory distribution was obtained by slow infusion of spheres via peripheral veins: external jugular vein for lung and small mesenteric vein for liver. Normal dog liver tolerated doses of internal radiation from ^{90}Y microspheres up to and including 100 mC in a single dose with only transitory dysfunction, but 200 mC, which is equivalent to about 115,000 rad, to liver exceeded its tolerance. There was no depression of the hematopoietic system in these animals. The effect on growth of experimental tumors was evaluated, and, in all studies, marked protective effects were noted. Clinical application in 22 patients with tumors, either primary or metastatic, of the lung, liver, prostate, urinary bladder, breast, stomach, and other soft tissues was carried out by direct or blood stream infusion of ^{90}Y microspheres. In six patients, death occurred before any change could be expected. The remaining patients, alive or having lived sufficiently long manifested suggestion of beneficial effects although objective evaluations were difficult. It is suggested that response to this therapy and chemotherapy is related to vascularity of the tumor. A massive dose of radiation (up to 100,000 rad) can be given to a local area by this method without danger of bone marrow depression or general debility. (BBB)

22046 THE THERAPEUTIC APPLICATIONS OF ^{32}P IN MINOR POLYCYTHEMIA. E. Greppi and A. Miliani (Universita, Florence). Minerva Nucl., 8: 299-300(Nov.-Dec. 1964). (In Italian)

The results obtained by treating patients with minor polycythaemia with ^{32}P provides a basis for studying in some detail the compensatory phenomena found in this condition. It is possible that these phenomena become excessive and give rise to a new pathological condition due to over-compensation. (tr-auth)

22047 CLINICAL CRITERIA IN THE CHOICE OF ^{131}I TREATMENT. E. Greppi (Universita, Florence). Minerva Nucl., 8: 301-3(Nov.-Dec. 1964). (In Italian)

The criteria on which to base the choice of ^{131}I treatment in thyroid disorders are discussed. Clinical results on over 5,000 cases form the basis of the discussion. (C.H.)

22048 DIAGNOSTIC VALUE OF GAMMA ENCEPHALOGRAPHY IN BRAIN TUMOURS. M. F. Becchini, P. Fabiani, R. Giordani, H. Mugnaini, and G. Tusini (Università, Pisa, Italy). Minerva Nucl., 8: 303-11(Nov.-Dec. 1964). (In Italian)

The results of gamma-encephalographic examinations using ^{131}I-human serum albumin in 83 patients suspected to have brain tumors are presented. Of the 62 brain tumors examined, gamma-encephalography was positive in 51 cases. Some features of the gamma-encephalographic picture are briefly discussed. As regards the negative results obtained in 11 tumors, the importance of the site and histologic type of the tumor in determining a positive result is stressed. Observation during surgery, performed in most cases, confirmed the value of gamma-encephalography for a correct assessment of the extension of the tumor. (tr-auth)

22049 MEASUREMENT OF METABOLIC POOLS BY A NEW METHOD, THAT OF DYNAMIC ISOTOPE DILUTION. D. Nicolescou-Zinca (Inst. of Endocrinology, Bucharest). Minerva Nucl., 8: 312-13(Nov.-Dec. 1964). (In Italian)

A new technique is proposed for the measurement of metabolic pools. It is based on the dynamic isotope dilution method. The theoretical principles and practical features of the technique are described. (tr-auth)

22050 THE PROFILE COUNTING METHOD. DIAGNOSTICAL POSSIBILITIES AND TECHNICAL DEVICES FOR A PRACTICAL QUANTITATIVE EVALUATION OF THE DETECTION OF METASTATIC FOCUSES. G. L. Buraggi and P. Marano (Universita, Milan). Minerva Nucl., 8: 314-23(Nov.-Dec. 1964). (In Italian)

The method of profile counting for the detection of metastases caused by thyroid cancer has not had a very large application. Since this procedure is of considerable help in many cases, the original technique using ^{131}I was adapted to more modern equipment. In particular, attempts were made to obtain profile counting with a conventional scanner of the type routinely employed in scintigraphic examinations. A report is given of experimental results obtained by fantom measurements, upon calibration of instruments, and of some examples of in vivo application of the method both on unaffected patients and on patients with thyroid carcinoma metastasized to various sites. The way to calculate the focus activity from the graphical data of the radioactivity obtained is presented. The procedure is characterized by a quick performance, easy calculation, and reliability of results and for this reason deserves to be more generally used. (tr-auth)

22051 COLOUR SCINTILLATION SCANNING. B. Bellion, S. Chiarle, and E. Morgando (Universita, Turin). Minerva Nucl., 8: 385-9(Nov.-Dec. 1964). (In Italian)

The value of color scintillation scanning using ^{197}Hg- or ^{203}Hg-Neohydrin or ^{131}I-albumin as tracer, is compared with that of black and white and photographic scintillation scanning. With the former, variations of the activity in the examined organ can be quantitated, but photographic scintillation scanning has the sometimes essential advantage of magnifying the contrast logarithmically. (tr-auth)

22052 PATIENT DOSIMETRY IN X-RAY STUDIES OF CHILDREN. Helmut Fendel (Universitat, Tubingen, Ger.). Monatsschr. Kinderheilk., 112: 233-5(Apr. 1964). (In German)

The author briefly describes a diagnostic dosimeter apparatus, consisting of an indicator apparatus with a planar ionization chamber, which is placed immediately to one side of the depth diaphragm toward the patient. The size of the ionization chamber is chosen so that at max diaphragm size the entire cone of radiation is included. What is measured is the product of the ionization in R and the planar size in cm^2. At various object-focus distances the product remains constant, because the radiation intensity varies by the inverse square law, but the size of the radiation cone base increases. Here, it is not the dose or dosimetry that is involved, but rather the amount of radiation and radiometry. This type of measurement is the simplest to determine at this stage of development of x ray procedure. In terms of the planar dose, a thoracic image dose is about 2 R/cm^2 for young infants, and about 20 R/cm^2 for young adults. A sagittal and frontal cranial study is 30 to 35 times as much. For pelvic photographs in infants a planar dose close to 2 R/cm^2 is used. Five times as much is used for abdominal survey photographs. The surface dose to the male gonads is equivalent to about 3 or 4 times the normal environmental exposure during a thoracic photograph, but it may be equivalent to 20 days of exposure during a pelvic study, or to 70 days exposure when an abdominal study is made. By measuring planar dose the percentage of positive determinations can be increased, while the gonadal dose may remain the same, or even be reduced. If an image intensifier with television is used the planar dose can be reduced by 30 or 40%. This is an important advantage in fluoroscopic procedures. (BBB)

22053 PREFERENTIAL LOCALIZATION OF RADIOISOTOPES IN MALIGNANT TISSUE BY REGIONAL OXYGENATION. J. W. Finney, R. E. Collier, G. A. Balla, J. W. Tomme, J. Wakley, G. J. Race, H. C. Urschel, A. D. D'Errico, and J. T. Mallams (Baylor Univ., Dallas). Nature, 202: 1172-3(June 20, 1964).

It was observed that when certain isotopes are given intra-arterially, following the intra-arterial infusion of hydrogen peroxide, the isotope localizes preferentially in the malignant tumor area being infused. Studies were conducted in rats using the Walker 256 carcinosarcoma, rabbits using the VX-2 carcinoma, and in human beings with a variety of malignancies. The animals were infused with a 0.24% H_2O_2 in Ionosol T solution (5 ml in the rat and 10 ml in the rabbit) at a rate of 1-1.5 ml/min. The rats were then given 5 μC radioiodinated human serum albumin (RISA), the rabbits were given 15 μC. The RISA was flushed through with the H_2O_2 solution (2 ml for rats and 5 ml for rabbits). The animals were scanned externally at 24, 48, and 72 hr, then killed; the livers removed and sections taken from normal liver, liver adjacent to tumor, and tumor tissue. Activity was determined in a well-type counter. The ratio of isotope in the tumor when compared to normal tissue was 2:1 to 4:1, for both rats and rabbits. Animals receiving just Isonosol T with RISA showed no significant difference in isotope concentration between normal and malignant tissue. Other rabbit experiments consisted of animals bearing bilateral hindlimb implants of the VX-2 carcinoma. The animals were scanned at 24, 48, 72, 96, and 120 hr following infusion of RISA and H_2O_2. It was noted that the isotope concentrated primarily in the limb which received H_2O_2 and isotope. Again, the ratio of isotope in the tumor as compared to normal tissue was 2:1 to 4:1. The ratio of isotope in the tumor in the control-infused limb was 1.5:1 to 4:1. In control studies conducted in the 35 human beings in whom the RISA was given intra-arterially with no peroxide, no localization was noted. In the same patients given the isotope with peroxide, very good tumor localization of the isotope was noted. Three patients with brain lesions received the intra-arterial H_2O_2 and (3-(chloromercuri)-methoxy-propyl)-urea-^{203}Hg. Excision of the mass 24 hr after the scan dose was done. Radioautographs of tumor indicated that the isotope is associated with the malignant cells; very little isotope localized in the fibrous tissue, vascular tissue, or white cell components. It is concluded that both ^{131}I-labeled human serum albumin, and (3-(chloromercuri)-methoxypropyl)-urea-^{203}Hg localize preferentially in the area of malignant tissue when given intra-arterially during the intra-arterial infusion of dilute H_2O_2. (BBB)

22054 A FAST NEUTRON SOURCE FOR RADIOTHERAPY. J. J. Broerse and G. W. Barendsen (TNO, Rijswijk, Netherlands). Nature, 206: 208-9(Apr. 10, 1965).

The advantages of 15-Mev neutrons resulting from the D-T reaction in the radiotherapy of tumors are discussed.

It is pointed out that the depth dose characteristics of 150 Mev neutrons are favorable when compared with 8 Mv x rays and recent investigations have shown that adequate collimation is feasible and the oxygen enhancement ratio for neutrons is much lower than for directly ionizing particles of comparable LET. Experimental data are presented that show a gain factor of 1.5 for 15-Mev neutrons. Technical problems that have not been solved include construction of a neutron generator with adequate output able to produce a beam as high as 20 mamp and an increase in target half-life. (C.H.)

22055 COMPARATIVE STUDY OF RADIOACTIVE CHLORMERODRIN (NEOHYDRIN) TAGGED WITH MERCURY-197 AND MERCURY-203 FOR BRAIN SCANNING. Y. Lucas Yamamoto, William Feindel, and Joan Zanelli (McGill Univ., Montreal). Neurology, 14: 815-20(Sept. 1964).

Neohydrin tagged with ^{203}Hg is a useful agent for brain scanning. In double isotopic studies with quantitative scans it was found to give about double the uptake at three hr compared with that at 24 hr for human serum albumin tagged with ^{131}I (RISA). However, a disadvantage is the relatively high radiation dose delivered to the kidneys by ^{203}Hg. Mercury-197 might be more suitable for scanning of certain organs, since it has unique physical properties which tend to overcome this disadvantage. These include a shorter half-life of 2.7 days, absence of β emission, and complex spectra of photon emission following electron capture and internal conversion. The usable photons from ^{197}Hg are abundant (98 photons/100 disintegrations) in the energy range of 66 to 78 kev. Of these, about 19% originate from unconverted 77.3-kev γ rays, 58% from 67- to 69-kev, Kα x rays, and 23% from 77 to 78 Kβ x-rays. On the basis of this data the radiation to the kidneys should be reduced to less than 3% of that expected from ^{203}Hg. On the other hand, the soft γ- and x-ray emission of ^{197}Hg, on theoretical grounds, could be a disadvantage in brain scanning due to the dense absorptive layer of bone surrounding the intracranial contents. To define the usefulness of ^{197}Hg, a comparative study was made of the two chlormerodrin agents tagged with ^{203}Hg and ^{197}Hg. The double isotopic method and quantitative scans were used in patients with verified intracranial lesions. The percentage differential uptakes of the lesions were about the same magnitude for various types of intracranial neoplasms. The optimal dosage of chlormerodrin with ^{197}Hg was found to be 5 μC/kg body weight or half of the dose for chlormerodrin tagged with ^{203}Hg. The radiation dose to the kidneys with chlormerodrin-^{197}Hg was less than 3% (1 rad) of that from chlormerodrin-^{203}Hg (40 rad). A correlation of positive scans with the presence of verified intracranial lesions was 86 to 90% with the use of either scanning agent. Reverse or negative scans could usually be attributed to limitation of the instrumentation in regard to midline or small lesions (less than 1 cm. in dia) and to the poor concentration of chlormerodrin by low-grade gliomas. It is concluded that chlormerodrin-^{197}Hg gives scans as satisfactory as those from chlormerodrin-^{203}Hg, and allows the radiation dosage to the kidney to be reduced to a negligible level. (BBB)

22056 RADIOACTIVE ISOTOPES IN CLINICAL MEDICINE (CONCLUDED). Solomon Silver (Mount Sinai Hospital, New York). New Engl. J. Med., 272: 569-74 (Mar. 18, 1965).

Clinical uses of radioisotopes discussed include the use of $H_2{}^3O$ in measurements of body water; the use of ^{22}Na, ^{24}Na, ^{82}Br, and ^{35}S in studies of intracellular water on electrolyte balance; the use of ^{42}K or ^{86}Rb to measure exchangeable K; the use of ^{24}Na and ^{22}Na in studies of Na exchange; the use of ^{82}Br as a substitute for Cl in studies on exchangeable chloride; the use of ^{45}Ca and ^{47}Ca in studies of Ca metabolism; the use of ^{28}Mg in studies of Mg metabolism; the use of ^{131}I, and ^{32}P, ^{72}Ga, ^{18}F, ^{47}Ca, ^{85}Sr, ^{87}Sr, ^{197}Hg, ^{203}Hg, and ^{75}Se in the localization of tumors, the use of vitamin B_{12} labeled with ^{57}Co, ^{58}Co, or ^{60}Co in the diagnosis of pernicious anemia and malabsorption syndrome; and the use of ^{198}Au, ^{131}I, or ^{197}Hg and ^{203}Hg labeled compounds for liver and kidney function studies. Other less common diagnostic and therapeutic uses of radioactive isotopes are discussed briefly. (65 references.) (C.H.)

22057 STUDIES OF THE LUNG CHANGES FOLLOWING ROENTGEN TREATMENT. PART 1. FREQUENCY OF INCIDENCE OF LUNG CHANGES FOLLOWING ROENTGEN TREATMENT FOR BREAST CANCER, AND THE CORRELATIONS OF IT WITH SOME PHYSICAL AND INDIVIDUAL FACTORS. Akira Kikuchi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 21: 1030-46(Feb. 25, 1962). (In Russian)

Seventy cases of postoperative breast cancer irradiated from 1955 to 1959 were followed up over six months after the end of the treatment. Thirty-eight cases (54.3%) were found to have radiation-induced changes of the lung as shown by radiography of the chest. The irradiation involved a direct portal technique with orthovoltage x rays. The number of the treated areas and the over-all time for the radiation therapy showed no correlation with the frequency of lung changes. The threshold dose for radiation lung changes was found to be 3250 R. The dose was measured at a point 8 cm below the surface of a chest phantom. The frequency of changes in the first group receiving a lung dose less than 3500 R was calculated to be 25.0%, while for the third group receiving more than 4200 R it was 76.2%. The difference between the frequencies in the two groups was significant. The second group, which received a moderate dose (from 3500 to 4200 R) showed a incidence rate of 51.4%. From these results, not only the lung dose but some other factors as well were suspected to be involved in causation of the lung changes following radiation therapy. Correlation between the time-dose relation and the frequency of incidence, studied by a rectangular coordinate system, showed that the incidence rate of the lung changes of the 36 cases situated above the line for the regression equation $y = 32.3x + 2575$ (where y represents total dose in R and x the number of days over which it was delivered) was very high (72.2%), while that of 34 cases situated under the line was 35.3%. The difference between the two was significant. Variables such as age, general condition, blood pressure, and radiosensitivity, as represented by severity of radiation sickness, were examined statistically, and found to have no relation to the incidence of the lung changes. All six cases which had had pneumonia, bronchial asthma, and pulmonary tuberculosis and one of three cases which had had pleuritis on the irradiated side were found to have the lung changes after irradiation for breast cancer. (BBB)

22058 STUDIES OF THE LUNG CHANGES FOLLOWING ROENTGEN TREATMENT. PART 2. CLINICAL, ROENTGENOLOGICAL, AND PATHOLOGICAL STUDIES ON THE LUNG CHANGES FOLLOWING ROENTGEN TREATMENT FOR BREAST CANCER AND ESOPHAGEAL CANCER. Akira Kikuchi (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi, 21: 1047-74(Feb. 25, 1962). (In Japanese)

In a study of 45 patients, the early stage of the lung changes, i.e. radiation pneumonitis, was observed in 38 cases of breast cancer and a case of esophageal cancer, while a later stage, i.e. radiation fibrosis, was observed in 30 cases of breast cancer. Radiologic findings of radiation pneumonitis and fibrosis are described and each condition was classified into three grades. Radiation pneumonitis was divided according to the extent of the lung changes shown by the posterior-anterior projection. Radiation fibrosis was also divided according to the extent of the lung changes shown six months after the finding of pneumonitis. In all cases of radiation pneumonitis, the typical roentgenologic shadows were found within eight months after the irradiation, and in 3.1 months on the average. Most appeared in upper and middle lung fields, but not always in the anterior portions of the lung. Eight of 30 cases of pneumonitis followed up more than six months showed complete resolution of the shadows of pneumonitis could be seen and they all occurred within six months. In the other 22 cases the shadows of pneumonitis developed

into fibrosis. Some of the grade 1 cases of pneumonitis disappeared with no residue, but the others developed to fibrosis of grade 1 or 2, while grade 3 cases of pneumonitis all developed to fibrosis. In eight cases of radiation fibrosis followed up over two yr after the onset, movement of the location of the shadows, owing to the shrinking of lesions was noted. In 22 of 38 cases of pneumonitis (58%), the radioinduced injuries produced clinical symptoms. The symptoms consisted of cough, dyspnea, and chest pain, and they occurred mainly before the roentgenographic changes were apparent, in 2.4 months after irradiation on the average. There existed a parallel between the severity of the damage as seen roentgenologically and the clinical symptoms. On the whole the symptoms were not serious in the cases of breast cancer, but the patient with esophageal cancer died of radiation pneumonitis on the 24th day after irradiation. Lung function in nine cases of radiation fibrosis was examined; the results were as follows: (1) decrease of vital capacity, (2) increase of residual volume, and (3) marked disturbance of gaseous diffusion. Since the disturbance of diffusion was much greater than could be accounted for the severity of the shadows of fibrosis, the conclusion was drawn that lung tissue which did not show pathologic shadows may also have been damaged by irradiation. (BBB)

22059 STUDIES ON AREA SCANNING WITH ^{125}I. Takekuni Kasuga (Chiba Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 976-82(Nov. 1963). (In Japanese)

The distinct visualization of an organ or a tissue by radioisotope scanning is difficult with emitters of high-energy γ rays. In general, the higher the energy of γ rays, the lower the resolution. The main energy peak of γ rays of ^{131}I is 364 kev, which is too high for good resolution. This report describes experiments with ^{125}I, which emits lower energy radiation, including a 27.4-kev x ray and 35.4-kev γ ray. A scan of the thyroid gland and liver was made with ^{125}I to see how the contours of these organs can be improved compared with ^{131}I. When ^{125}I was used in area scanning, the contours of thyroid gland were clearly delineated, and the background was very low. Therefore, it is easier with ^{125}I thyroid scanning to obtain the accurate size of the thyroid gland and to find cold nodules in the gland, as compared with ^{131}I. These scans were obtained by oral administration of about 50 μC of ^{125}I to the patients, except those with hypothyroidism. In cases of hyperthyroidism, thyroid scanning is possible after administering smaller dose of ^{125}I. On the other hand, it is difficult to measure the accurate thyroid ^{125}I uptake, because of its low energy. If thyroid uptake and scanning are done simultaneously 10 μC of ^{131}I is given with ^{125}I to the patient. By differential counting measurements the precise thyroid uptake will be obtained. In this case, the influence of the scattered radiations of ^{131}I in the scintigram with ^{125}I is slight, and accurate thyroid scanning is obtained. In liver scanning, tumors near the surface of the liver are precisely located by the use of ^{125}I. However, it is almost impossible to locate deep-seated tumors of the liver by ^{125}I scanning. These are best found by the use of ^{131}I. In liver scanning it is suitable to use ^{125}I at first and then to scan again with ^{131}I or ^{198}Au. By this method more information on changes in the liver will be obtained than by scanning with ^{131}I only. As ^{125}I has no β-particle emission, the radiation exposure to the patient will always be less, if it is used in place of ^{131}I in the scanning of various organs. (BBB)

22060 CLINICAL STUDIES ON THE MEASUREMENT OF LIVER INTAKE OF RADIOISOTOPES. Teruo Tokuyama (Chiba Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 1383-92(Feb. 1964). (In Japanese)

The intake of ^{198}Au colloid by normal livers is about 90% of that intravenously injected; this value was taken as the standard in the study. A remarkable decrease in the liver intake was observed in the hepatopath. The mean value of liver intake of ^{198}Au colloid for hepatocirrhosis was 55% of that injected, and for chronic hepatitis, 62%. The mean value for serious hepatocirrhosis was 40%, but for mild cases, 62%; and values for serious and mild hepatitis were 57% and 85%, respectively. Hence it is possible to use measurements of the liver intake of ^{198}Au colloid for the diagnosis of hepatopathies. (NSA of Japan)

22061 STUDIES ON PREOPERATIVE AND POSTOPERATIVE TELECOBALT THERAPY IN GASTRIC CANCER. REPORT XV. Tatuo Takahashi (Yuri Kumiai General Hospital, Akita, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 891-6(Oct. 1964). (In Japanese)

When the field of irradiation is to be determined in treating patients with stomach cancer, the tumor is, in most cases, regarded as the target of irradiation in the case of a patient who is not going to be operated on. It is necessary, however, in the case of a patient who has been operated on, that the irradiation target should include, anatomically and systematically, lymphatic glands and lymph nodes, based on the findings of the operation. Above all, the lymph nodes of the hepatic portal and retroperitoneal wall should not escape treatment because they are most frequently subject to relapse and metastasis. (auth)

22062 A METHOD OF SKIN DOSE CALCULATION FOR ARC THERAPY. II. BACKSCATTER FACTOR FOR RECTANGULAR FIELDS OF ^{60}Co GAMMA-RAY, ^{137}Cs GAMMA-RAY AND MEDIUM ENERGY X-RAY. Takeshi Yamazaki and Akimune Hayami (Osaka Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 916-20(Oct. 1964). (In Japanese)

In order to provide some basic data on methods of skin dose calculation for arc therapy, backscatter factors for the diaphragm-limited rectangular fields of ^{60}Co γ rays, ^{137}Cs γ rays, and 190 kvp x rays are measured by the smallest thimble ionization chamber (air volume 0.2 cc, inside diameter 4 mm), related to field size and field elongation, and compared with those of Brit. J. Rad. Suppl. 10. (auth)

22063 Cs^{131}— A NEW ISOTOPE FOR PANCREATIC SCANNING IN ANIMALS. D. Bruce Sodee (Doctors Hospital and Renner Clinic Foundation, Cleveland Heights, Ohio). Nucleonics, 23: No. 4, 56; 58(Apr. 1965).

Investigations on guinea pigs and dogs indicate that ^{131}Cs concentrates with some selectivity in the pancreas of these animals. Moreover, because ^{131}Cs decays by emitting only a 29.4-kev x-ray, the isotope would deliver a smaller patient dose than ^{75}Se, the presently used scanning agent. (C.E.S.)

22064 RADIATION DOSES IN ORAL RADIOGRAPHY. I. MEASUREMENTS OF DOSES TO GONADS AND CERTAIN PARTS OF HEAD AND NECK DURING FULL MOUTH ROENTGENOGRAPHY. Bengt Bjarngard (Aktiebolaget Atomenergi, Studsvik, Sweden), Lars Hollender, Bengt Lindahl, and Anders Sonesson. Odontol. Revy, 10: 355-66(1959).

Radiation doses to the gonads and certain parts of the head and neck were measured during full mouth roentgenography with apparatus and technique used at the Royal Dental School in Malmo, Sweden. The total exposure time for 14 films was 30.5 sec. The x-ray machine was operated at 60 kvp with a tube current of 10 ma, no added filter, HVL 1.2 mm Al, output 3.5 R/sec, target-cone tip distance 14 cm, dia of field at the cone tip of 5.2 cm. A head-neck phantom was used consisting of a cranium with the soft tissue parts replaced by tissue equivalent material, Mix D. A water phantom containing the skeletal parts of the abdominal region was used for measurement of the dose delivered to the gonads. According to the measurements, the testes received on the average a dose of 0.9 mrad and the ovaries 0.4 mrad during full mouth roentgenography. The contribution by the single exposures are shown. The doses measured on the patients varied widely and were sometimes twice as large as the mean values. The average dose received by the eye during full mouth roentgenography was 1500 mrad. The largest dose recorded was 7000 mrad. The dose was found to be 500 mrad for the thyroid and 2000 mrad for the submandibular glands. The dose received by the mouth was measured in a region where all the fields overlapped. Measure-

ments on the phantom showed that this dose was about 35 rad per full mouth roentgenographic examination. The max dose delivered to the surface of the skin was on the average 26 rad, but doses up to about 30 rad occurred. Assuming that the jaw bone received the largest dose where the fields of the upper and lower bicuspids and cuspids overlapped and that this region was within a 0.5 cm thick layer of soft tissue, the max dose of the bone was calculated to be about 90 rad. This implies that the absorbed dose in the outer layer of the teeth was at most 180 rad in the same region. Assuming that all radiation to the head and the neck is absorbed, the integral dose was estimated to 2800 g·rad. In this calculation, it was assumed that the energy flux per R was 120 ergs/r·cm^2. Compared with the values given by most previous investigators the doses received by the gonads are small. (BBB)

22065 RADIATION DOSES ON ORAL RADIOGRAPHY. II. THE INFLUENCE OF TECHNICAL FACTORS ON THE DOSE TO THE PATIENT IN FULL MOUTH ROENTGENOGRAPHY. Bengt Bjarngard (Aktiebolaget Atomenergi, Studsvik, Sweden), Lars Hollender, Bengt Lindahl, and Anders Sonesson. Odontol. Revy, 11: 100-12(1960).

The effect of variations in the half-value layer and field size on radiation doses to the gonads and to certain regions of the head and neck of the patients was studied during full-mouth roentgenography, and the relation between film dose and image quality was considered. The doses received by gonads, thyroid, and submandibular glands were proportional to the field size at diameters of 5.0 and 7.0 cm. The maximum skin dose increases twofold on increase of the field dia from 5.0 to 7.0 cm. Previous investigation showed a max skin dose of 26 rad at a field dia of 5.2 cm, thus showed a max skin dose of 26 rad at a field dia of 5.2 cm, thus the max skin dose at a beam dia of 7.0 cm will be about 50 rad. Even at a field dia of 5.0 cm there is some risk of direct irradiation of the eye. This risk increases with further increase of the field dia. According to measurements on a head and neck phantom, the eye dose increases sevenfold on increasing the field dia from 5.0 to 7.0 cm. The mean eye dose in the previous investigation was 1.5 rad at a dia of 5.2 cm for full-mouth roentgenography. Measurements of the variation of dose with half-value layer were made in different regions of a phantom. The skin dose decreased with half-value layer as the exposure time decreased, neglecting the small influence of the backscatter factor. The doses to the thyroid and submandibular glands were independent of variations in half-value layer. The mouth dose increased appreciably with half-value layer. The gonadal dose also increased markedly with half-value layer. The results show that the field size should be as small as possible. A field more than 5.0 cm in dia at the tip of the cone should not be used in intraoral roentgenography with films 3 × 4 cm. It is easy to insert the necessary limiting lead diaphragm for reducing the field dia to 5.0 cm. This means a considerable reduction of dose to the patient and also reduces the scattered radiation received by the operator. The variations of the doses with field dia, half-value layer, and exposure time are tabulated for a 60-kvp x-ray apparatus that was used during the dose measurements in the previous investigation. A half-value layer between 1.5 and 2.5 mm aluminum is recommended. It is stressed that min exposure time producing acceptable roentgenograms should be used. (BBB)

22066 RADIATION DOSES IN ORAL RADIOGRAPHY. III. A LIMITED SURVEY OF DENTAL X-RAY UNITS. Bengt Bjarngard (Aktiebolaget Atomenergi, Studsvik, Sweden) and Lars Hollender. Odontol. Revy, 11: 193-206(1960).

A survey was made of dental x-ray units and procedures, including 62 units in Malmo (Sweden) and its surroundings. The routine investigation of a unit included type of apparatus, field diameter at the tip of the cone, target-cone tip distance, half-value layer, exposure dose rate in air at the tip of the cone, exposure times for full-mouth roentgenography, development time, and film used. Mean beam diameter at the tip of the cone was 8.0 cm, and the mean half-value layer was 1.2 mm aluminum. The mean values of R used (product of exposure dose rate at cone tip and exposure time for full mouth pictures) was 40 R. The mean R·cm^2 used (product of R used and field area at cone tip) was 2000 R·cm^2. Penumbras and too short development times occurred frequently. As a mean, the R·cm^2 used could be 6.4 times less, if the same films were used but all units had proper technical data. Of this, a factor 1.4 is due to unnecessarily small half-value layers, a factor 1.8 to too large film doses, and a factor 2.6 to the too large fields. For fast films the number of R·cm^2 used should not exceed 300 R·cm^2 and the number of R used should not exceed 14 R. Doses are calculated for the mean x-ray unit of the investigation. Some recommendations are given to the dentist on how to reduce the radiation hazards of his x-ray apparatus. The dentist should test his field area by placing a large film at the tip of the cone and exposing it for about half a second. By inserting a lead diaphragm in the cone, the field diameter can easily be cut down so it does not exceed 5.0 cm at the tip of the cone. The added filtration in most dental units should be about 1.0 to 2.5 mm aluminum. The exposure times should be successively cut down to a minimum, and the development time should be long enough that no exposure is wasted. (BBB)

22067 CHANGES IN EXCRETION OF 17-KETOSTEROID AND 17-OHCS (ALPHA-KETOL) AFTER RADIATION TREATMENT OF FEMALE GENITAL CARCINOMA PATIENTS. Zoltan Szereday and Menyhert Szegvari (Orvostudomanyi Egyetem, Szeged, Hungary). Orv. Hetilap, 104: 2465-6(Dec. 29, 1963). (In Hungarian)

Tests were conducted to determine whether changes can be observed in the excretion of various steroid hormones after combined Ra and x-ray treatment, and whether there is any correlation between the changes in the function of the adrenal cortex and the age of the patient, progression of the disease, and the stresses of the repeated radiation treatments. Attempts were also made to determine whether any diagnosis or prognosis can be made on the basis of steroid hormone excretion to evaluate the success of the treatments. Treatment of 30 cervical cancer patients consisted of three Ra implantation at 10-day intervals, and x irradiation was given after the second Ra treatment in doses amounting to 40 × 200 R. The patients received 6000 mg-hr Ra and 8000 R x irradiation. Urine was collected every other day before and after the treatments and assayed for 17-ketosteroids and 17-hydroxycorticosteroids (17-OHCS), and for creatinine as a reference standard. The following changes were recorded after the first Ra treatment, indicated as a decrease (–) or increase (+) compared with control levels: urine volume, –115 ml/24 hr; creatinine, –0.08 g/24 hr; 17-KS, –0.80 mg/24 hr; and 17-OHCS, –0.3 mg/24 hr. The respective values after the second Ra treatment were: –196, –0.15, –0.78, 0.0; and after the third Ra plus x-ray treatment: –108, –0.10, –0.80, +3.6. Thus only the last treatment produced significant changes, increasing 17-OHCS excretion. This is attributed to the increased radiation stress on the patient's endocrine system rather than to a decreased activity of the adrenal cortex due to carcinoma. No correlation was discovered between the age of the patient, the progression of malignancy, and the irradiation delivered. The results showed no significant basis for prognostic predictions. (BBB)

22068 TREATMENT OF PALPEBRAL CARCINOMA BY IRRADIATION. Ian MacDonald and Robert J. McKenna. Pacific Med. Surg., 72: 356-9(Nov.-Dec. 1964).

In a series of several hundred patients treated for squamous and basal cell carcinomas of the eyelid, radiation therapy was found to be the best treatment. So satisfactory were the results, both as to eradication of neoplasm and a virtual absence of significant sequelae, that radiotherapy is recommended for primary attack on palpebral carcinoma, with rare exceptions. A lead shield is used to protect the eye, leaving about a 0.5-cm margin around the tumor to be irradiated. Fractionated x ray is

given in single doses of 500 R in air twice weekly, to a total of 3000 R in air, with few exceptions. When the reaction is more intense than average the total may be reduced to 2500 R. In occasional patients the total dose was carried to 3500 to 4500 R. In 89% of this series the total dose was 3000 R. Most patients showed moderate erythema of the treated area, which usually subsided in 14 to 20 days. Application of a lanolin ointment several times daily was the only necessary measure for treating this erythema. The eyelid neoplasms were controlled by irradiation for more than 5 yr in 97% of the patients. Sequelae of irradiation are described. With the technic used the cosmetic result was usually remarkably good. Only by close inspection, after healing, was some slight atrophy and loss of elasticity seen. Occasionally there was depigmentation of the treated area until exposed to actinic radiation. In only three patients was there telangiectasia, and in one patient a mild ectropion. No cataracts have been seen in consequence to therapy. These good end-results are due to the use of a proper quality of irradiation, plus fractionation. In persons with a so-called red-headed skin, or when involvement of cartilage is apparent, the technic is changed in favor of a harder beam (HVL of 0.25 mm Cu, instead of 0.18 mm as used above), with smaller increments over a longer period of time, e.g., 300 R in air, three times weekly. From a cosmetic viewpoint, these results are far better than achieved by surgical excision. (BBB)

22069 THE ACUTE AND CHRONIC COLPOCYTOLOGICAL REACTION CAUSED BY RADIATION. R. Alicino and L. Scarpellini (Universita, Rome). Quaderni Clin. Obstet. Ginecol., 17: 34-47(Jan. 1962). (In Italian)

A study was made on 187 patients affected with carcinoma of the uterine cervix in the first, second, and third stages. None of the patients presented clinical symptoms or colpocytological evidence of metastatic neoplasia at the time of study. Eight days to 20 yr after radiotherapy, biopsies were performed and repeated two to twelve times to evaluate the effect of radiation on vaginal cells. The biopsies were stained according to the Papanicolaou method. To exclude normal variations, 100 colpocytological smears of menopausal women free of cancer and never irradiated were observed. All patients studied underwent radical Wertheim hysterectomy and afterwards received radiotherapy in two Ra sessions at an interval of eight to ten days, and x-ray therapy in three cycles totaling 30 treatments at intervals of 45 days, three months, and six months to give a total dose of 18,000 R. In observations, after three and six months, one, two, five, ten, 15, and 20 yr, progressive decrease of superficial cellular desquamation and increase of the diffuse type radiation-caused giant cell reactions were observed. As a chronic effect of irradiation, alterations in the genetic features of the germinative epithelial cells of the vagina were seen. On the basis of its morphological characteristics it was classified as an anaplastic transformation. When found in patients 20 years after radiotherapy, free of cancer and in good health, this cell structure is the stigma of probable irreversible radiation damage, is ineradicable, and is pathognomic of irradiated vaginal epithelia. (TCO)

22070 LATE EFFECTS AFTER RADIUM IRRADIATION OF A KNEE-JOINT SKIN HEMANGIOMA. A. Schreiber (Universitat, Zurich). Radiol. Clin., 33: 300-6(1964).

Treatment with radium molds of a hemangioma situated close to the knee joint in an 8 months old female infant was followed later by gradual development of a genu valgum deformity. At the age of 11 years this became so severe as to cause dislocation of the patella and necessitate corrective osteotomy. There was good correlation between the calculated depth doses, which fell off rapidly from the lateral towards the medial side, and the observed growth inhibition and the expected radiation damage as culled from the literature. In view of the danger of delayed radiation effects upon the skeleton and the known genetic hazards, radium mold treatment of hemangiomata in infants and children is no longer advised. (C,H.)

22071 THE RADIATION BURDEN OF THE PATIENTS IN THE ROENTGENOLOGY. G. Fuchs (Kaiser-Franz-Josef-Spitals, Vienna). Radiol. Diagn., 4: 373-8(1963). (In German)

Basic research in radiobiology revealed the existence of somatic and genetic hazards of relatively small radiation doses. Measures have to be taken to reduce the radiation load of patients particularly so far as the gonads and the hematopoietic system are concerned. Examples are given for reducing the patients' dose both in x ray diagnostics and radiotherapy. (auth)

22072 HOW TO ECONOMIZE DOSES IN RADIODIAGNOSIS BY CHOOSING THE PROPER FILM-MATERIAL. W. Angerstein (Forschungsinstitut fur Tuberkulose und Lungenkrankheiten, Berlin). Radiol. Diagn., 4: 387-91(1963). (In German)

Twelve different types of home- and foreign-made x-ray films, among which 10 to be used with foils, were investigated with regard to the mAs-requirement for obtaining a specific film blackening. Furthermore phantom shots of Landoldt rings and small cylinders behind a scattering body were examined in order to find out to which degree details are visible. While the visibility of details of all types of films shows only little difference, the necessary mAs-requirement for obtaining the same blackening in the range between S = 0.5–1 for foil-films was found to be different in a proportion of 1:4. For the 2 types of films which were used without foils a considerable difference in sensibility was found. The possibility of introducing more sensitive types of films for routine use in diagnostic radiography is discussed. (C,H.)

22073 ATOMIC RADIATION IN MEDICINE AND TECHNOLOGY. G. H. Schneider. Radiologe, 3: 375-7 (Sept. 1963). (In German)

Use of radioisotopes in diagnosis, treatment, and research is reviewed. (BBB)

22074 RADIOBIOLOGY IN RADIATION THERAPY. Frank R. Hendrickson (Presbyterian–St. Luke's Hospital, Chicago). Radiology, 84: 727-34(Apr. 1965).

Radiobiologic information is summarized which might conceivably be used to produce greater radiation effects upon malignant tumors with less overall dose or, conversely, a greater effect upon tumors with doses now commonly used. It is emphasized that while this might be a desirable end, it is not our real problem. High-energy equipment and current technical abilities make it possible to destroy tissue in any portion of the body. It is really the ratio of tumor injury to normal tissue injury that is of greatest interest. If a rational combination of all methods for increasing radiation effect increased the effect on normal tissue concomitantly, no improvement in the therapeutic ratio would be achieved. (auth)

22075 PRELIMINARY EXPERIMENTAL RESULTS FOR A BIOLOGICAL TREATMENT OF CANCER AND CONSIDERATIONS DERIVED FROM IT FOR FURTHER STUDIES. U. Nuvoli (Ospedale Policlinico, Rome). Riforma Med., 77: 1053-66(Sept. 21, 1963). (In Italian).

Attempts were made to develop a method whereby immunologic reactions against a tumor were induced by bone marrow transplantation after irradiation. Bone marrow homografts in mice with spontaneous mammary cancer were used. Such grafts take readily if the animal's immunogenic reactivity is suppressed by total-body irradiation with 1025 R, which completely destroys his own bone marrow. To destroy the reticuloendothelial system, doses between 4000 and 4500 R must be used. Animals irradiated with 1025 R without receiving a marrow homograft died within 15 days due to aplastic anemia. The deaths were accelerated by general septic reactions caused by the complete immunologic unreactivity. No adverse reaction was observed when the tumor only was irradiated with 1025 R; the tumor regressed, which was followed by renewed development and ulceration, and the animal was dead within a month. Beneficial effects were observed in nearly all the animals which received a marrow trans-

fusion, but their deaths were due to antibody reactions caused by the donor hematopoietic tissue which was introduced (homologous disease). It is suggested that the tumor acted as a heterogenous tissue and was subjected to injury by the antibodies formed to it. However, the immunologic reaction was not adequate to completely destroy the tumor which became the dominant factor, inducing a state of cachexia, similar to that seen in homologous disease. (BBB)

22076 SCINTILLATION SCANNING OF THE BRAIN WITH MERCURY-203 NEOHYDRIN: TECHNICAL CONSIDERATIONS AND CLINICAL EVALUATION. Robert L. Murray (Univ. of North Carolina, Chapel Hill). Southern Med. J., 56: 914-20(Aug. 1963).

Mercury-203, as an agent for brain tumor localization, has physical and biologic properties that are superior to those of ^{131}I-labeled albumin. Physically, ^{203}Hg has a single line γ emission at 0.28 Mev, an energy level which is optimum for effective shielding and collimation with lead. In the use of ^{131}I, even with pulse-height analysis, it is impossible to prevent scattered radiation from the higher energy γ emission at 0.64 Mev and 0.72 Mev from interfering with the major γ emission of 0.36 Mev. Under these circumstances resolution of the target area by the collimator is not as efficient. The physical half life of ^{203}Hg is 45 days (longer than the 8-day half life of ^{131}I) is not a disadvantage, since ^{203}Hg is incorporated in the mercurial diuretic chlormerodrin (Neohydrin), which has a relatively short biologic half life. The whole-body radiation dose from the method is about 290 mrad, which is much less than the 700-mrad dose from the ^{131}I-labeled albumin technic. The kidneys receive 35 to 40 rad from a brain scanning dose of ^{203}Hg-Neohydrin since about 10% of the administered dose is bound in the kidneys with a biologic half life of 28 days. The kidney dose can be reduced by two thirds by giving nonradioactive mercurial diuretic on the day before the radioactive tracer is given. The average intravenous dose of ^{203}Hg-Neohydrin is 600 μC, and scanning is begun 3 to 4 hr after administration of the tracer. Scans in both frontal and lateral positions are made. Scanning was done with automatic scanner utilizing a heavily shielded 2 × 3 in. Tl-activated NaI crystal and a 19-hole focusing collimator. Pulse-height analysis was used with a 0.10-Mev window centered for the 0.28-Mev photopeak of ^{203}Hg. Isotope scanning in 50 patients suspected of having brain tumors detected 88% of confirmed intracranial lesions, and yielded no false positive results. Scanning proved valuable in many instances in accurate localization of tumors prior to operation, provided a means for follow-up evaluation of the postoperative and postradiotherapeutic results. An advantage of isotope localization over conventional neuroradiologic technics was that it defined the actual tumor in its bed rather than showing displacement of vessels or air-filled structures as indirect signs of tumor. (BBB)

22077 THE USE OF WEDGE FILTER TECHNIQUES FOR ^{60}Co IRRADIATION. Klaus Welker (Robert-Rossle-Klinik, Deutsche Akademie der Wissenschaften, Berlin). Strahlentherapie, 126: 331-8(Mar. 1965). (In German)

Application of wedge filters for the irradiation of large areas with ^{60}Co is reported. Several methods for using these wedge filters are demonstrated by means of thorax irradiation. In this case the vertebral bodies are exposed to a low radiation burden only. Calculation of the most favorable wedge angle for a given irradiation case is described. (tr-auth)

22078 REPORT ON THE EFFECTIVENESS OF SOME CYTOSTATICA AND IONIZING RADIATION. PART 2. MORPHOLOGICAL AND FUNCTIONAL INVESTIGATIONS OF BONE MARROW AND SPLEEN ON INBRED RATS WITH INOCULATION TUMORS. SURVIVAL TESTS AND RECOVERY QUOTAS AFTER DIFFERENT KINDS OF TREATMENT. Rudolf Schneider (Universitat, Marburg, Ger.). Strahlentherapie, 126: 339-65(Mar. 1965). (In German)

Both the cure rates and the side reactions in the bone marrow and spleen were investigated using albino rats of an inbred strain with inoculated tumors (Yoshida-sarcoma, Walker-carcino-sarcoma, and Jensen-sarcoma) after radiation therapy and chemotherapy (cyclophosphamide, triethyleniminobenzoquinone), both administered separately and combined. The results, however, cannot be applied readily to humans. The results indicated that telecobalt therapy had the same effect on these inoculation tumors which were found to be especially sensitive to cytostatic substances. By combining the methods, better results were obtained with a local pre-irradiation, using short source skin distance conditions, followed by a fractionated chemotherapy with small daily doses. (tr-auth)

22079 AN EXPERIMENTAL IRRADIATION ARRANGEMENT WITH LOW CONTINUOUS DOSE RATES. Premysl Vorisek (Anstalt fur Mutter- und Kinderfursorge, Prague). Strahlentherapie, 126: 468-74(Mar. 1965). (In German)

A device for continuous γ-irradiation with low dose rates (2.5 R daily) was developed. The device has a dose distribution homogenous in space. Dose differences in the different layers do not exceed the normal ±10% error limitations of the common dosemeters. Closed ^{60}Co samples are used as radiation sources. The geometric design of these radiation sources is described, and it conforms with the assumptions used. The results show that this method can be used to study damage, damage prevention, and adaptation mechanisms in organisms exposed to chronic irradiations. (tr-auth)

22080 DISTRIBUTION OF DEPTH DOSES IN BIOLOGICAL OBJECTS IRRADIATED IN MIXED GAMMA-NEUTRON FIELDS. B. R. Kirichinskii (Bogomolets Inst. of Physiology, Academy of Sciences, Ukrainian SSR). p.13-19 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

A survey is made of the important factors in estimating the depth distribution of doses in biological objects irradiated in mixed gamma-neutron fields. The review stressed the importance of the data on the integral doses (in addition to irradiation on exposition dose) or the data on the total amount of radiation absorption by the object and the distribution of the doses in the organs and tissues of animals. The relative value of the γ background must be determined as a ratio of the integral neutron and gamma absorption doses. (R.V.J.)

22081 LE CESIUM 137 EN TELETHERAPIE. (Cesium-137 in Teletherapy). R. Amalric and J. P. Vigne. Paris, Gauthier-Villars & Cie, [nd.]. 198p.

The uses of ^{137}Cs in teletherapy are discussed in some detail to stimulate new research and to facilitate the development of new cesium teletherapy sources. The physical bases of such therapy, practical dosimetry, proposed apparatus, principal irradiation techniques, the first clinical results obtained with ^{137}Cs teletherapy, advantages and disadvantages of cesium therapy, and the therapeutic indication are discussed. (J.S.R.)

22082 THYROID FUNCTION TEST WITH IODINE-125 AND IODINE-132. J. H. Scheeper. Thesis, Utrecht, Univ. of Utrecht, 1964. 120p.

It is investigated whether the radiation dose of the patient can be reduced by using different iodine isotopes for thyroid function tests. Two tracer methods are investigated. By the first method the measurements are started immediately after the intravenous administration of Na^{132}I. This test takes only 15 minutes and during this time the so-called initial accumulation rate is determined. In case ^{125}I has been applied the absorption of the gamma rays is so high that individual anatomic variations have a considerable influence on the test results. A method based on the combined use of ^{125}I and ^{132}I does not show the above mentioned drawback of high absorption. It was found that the information obtained by these test methods is at least as valuable as that obtained, if use had been made of ^{131}I. The radiation dose is reduced to less than a third of that with ^{131}I. (auth)

22083 HEPATIC BLOOD FLOW MEASURED BY THE PORTAL VENOUS AND HEPATIC ARTERIAL ROUTES

WITH KRYPTON 85. Milton Hollenberg (Cornell Univ., Ithaca, N. Y.). 3p. (CONF-650112-1).

From Symposium on Dynamic Function Studies with Radioisotopes, Boston.

Results are reported from studies on the portal venous and hepatic arterial blood flow in dogs measured with ^{85}Kr. Simultaneous determination of cardiac output showed that liver blood flow by the portal venous route represents about 27% of the total systemic output. Liver blood flow measured by the portal venous route was consistently higher than when measured by the hepatic arterial route. Results suggest that certain vascular channels are not served by both circulations. (C.H.)

CHEMISTRY

General

Refer also to abstracts 21791, 22891, and 24195.

22084 (BDX-613-70) A NEW DEVELOPMENT IN POLYURETHANE ELASTOMER PROCESSING WHICH REDUCES CRACK SUSCEPTIBILITY AND BUBBLE ENTRAPMENT. Donald D. Oswald (Bendix Corp., Kansas City, Mo.). Apr. 1965. Contract AT(29-1)-613. 23p. (CONF-650608-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From National Electronic Packaging and Production Conference, Long Beach, Calif.

A brush and test tube method was used to evaluate the feasibility of degassing polyurethane prepolymer. The test samples provided positive results that the crack susceptibility of polyurethane elastomers was greatly reduced as a result of degassing. Also, the samples of degassed material indicated a definite reduction in the number of trapped bubbles. Correlating the results tends to substantiate the theory that crack tendency and bubble entrapment are related. Comparing typical physical characteristics of elastomer samples, made from degassed and non-degassed prepolymer, gives additional verification to the relationship. The change in tensile strength is the most notable; values as high as 7000 psi have been measured. The manufacturing departments, using polyurethane prepolymer for encapsulation of electrical and electronic assemblies, have noted a definite decrease in scrap (due to bubbles and cracks) since introduction of degassed material. Assemblies that were difficult to encapsulate under a vacuum, because of problems other than voids, can not be encapsulated at atmospheric conditions and still stay within the void size tolerances. (auth)

Analytical Procedures

Refer also to abstracts 22693 and 22869.

22085 (ACF-5) AN ANALYTICAL CHEMISTRY EVALUATION— MACHINE HANDLING OF ANALYTICAL DATA. J. D. Allen (ACF Industries, Inc., Albuquerque, N. Mex.). Mar. 12, 1965. Contract AT(29-1)-1325. 37p. (ACF-413-233). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Developments in instrumentation have resulted in the rapid generation of volumes of data which must be assimilated and interpreted. A literature survey was conducted to determine the areas of analytical chemistry methodology in which computer handling of such data could be applied. X-ray emission spectroscopy, x-ray diffraction, electron probe analysis, mass spectrometry, neutron activation analysis, absorption spectroscopy, and gas chromatography were covered. It is pointed out that similar techniques and programs could be used in several of these areas. (D.L.C.)

22086 (AD-607286) SEPARATION OF THE RARE EARTH ELEMENTS. Final Report. (Pennsylvania State Univ., University Park). [nd]. Contract Nonr-65624. 9p. $1.00(CFSTI)

Systematic investigations were made on the synthesis of substituted 3-aminopropyl- and 2-aminoethylarsines for use in the separation of rare earth elements. Methods in which coordination compounds have been used in separation of metal ions are discussed. (P.C.H.)

22087 (AECL-2231) A FAST TEST FOR EXCESSIVE ^{235}U CONCENTRATIONS IN ENRICHED FUEL ELEMENTS. Alec D. McEachern (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1965. 18p. Dep.(mn); $0.50 (AECL)

An improvement to conventional methods of detecting areas of enriched fuel elements containing excessive ^{235}U is described. An instrument was designed to inspect uranium-aluminum alloy fuel for the NRU reactor using the improved method. The method was as precise as conventional methods but much faster. The reduction in testing time depended on the application, but typically could be by a factor of four. Alternatively, the improvement may be used to increase the precision of the test without increasing the testing time. The method may be used when the ^{235}U concentration in selected areas of a fuel element is estimated by measuring the intensity of 184-kev γ rays (from the natural decay of ^{235}U) and when an area is considered acceptable if the measured intensity from it is less than a limiting intensity equivalent to the maximum allowable ^{235}U concentration. If the measured intensity is much less or much greater than the limiting intensity, much less time is required to make this decision than when they are nearly the same. The method described takes advantage of this. Each area is thus inspected only as long as is necessary to make a decision with the required confidence. The average time taken is therefore less than that taken by conventional methods, which inspect each area for a pre-selected time chosen to give the required confidence in the most difficult cases, when the measured and limiting intensities are nearly the same. The method is based on sequential sampling theory. It may also be applied to tests for undesirably low ^{235}U concentrations. (auth)

22088 (AEET/Spec/12) ISOTOPIC ASSAY OF BORON-10 IN BORON TRIFLUORIDE BY SPECTROSCOPIC METHOD. S. L. N. G. Krishnamachari and B. R. Vengsarkar (Atomic Energy Establishment, Trombay (India). 1964. 13p. Dep.(mn).

A spectroscopic method was developed to determine the ^{10}B concentration of BF_3 at each stage of a distillation process. A molecular spectrum containing a boron atom that would give an appreciable $^{10}B-^{11}B$ isotope shift was obtained. Since the spectrum could be obtained with great intensity using very small amounts of BF_3 (about 2 mg) and also because the isotopic heads could be well separated even on a medium dispersion instrument, it was found suitable for the determination of ^{10}B isotopic concentration in enriched $^{10}BF_3$ samples. The standard deviation obtained from a number of readings varied from 1.7 to 2.7 in the concentration range studied; 20 to 90% of ^{10}B. The intensity ratio of the $^{10}BO_2$ and $^{11}BO_2$ band heads, plotted against the ratio of the ^{10}B and ^{11}B concentrations, gave a straight line, passing through the origin and inclined at 45° to the axes thereby showing that the bands do not suffer from any interference. It was concluded that the method could be used as an absolute one for the determination of ^{10}B concentration in enriched BF_3 samples. (P.C.H.)

22089 (AEET/Spec./14) SPECTROGRAPHIC ANALYSIS OF HIGH-PURITY Gd_2O_3 AND Dy_2O_3 FOR TRACE AMOUNTS OF OTHER RARE EARTHS. S. V. Grampurohit and Smt. K. Swamy (Atomic Energy Establishment, Trombay (India). Spectroscopy Div.). 1964. 14p. Dep.(mn).

An emission spectrographic method is described for the determination of Sm, Eu, Tb, and Dy in gadolinium oxide and Tb, Ho, Er, and Y in dysprosium oxide. Using d-c arc excitation, the spectra are photographed on a 3.4 meter Jaco-Ebert grating spectrograph having a 30,000 lines/inch grating. The concentration ranges covered are: Sm 0.02–0.05%, Eu 0.011 to 0.06%, Tb 0.04–0.5%, and Dy 0.03–0.5% in Gd_2O_3 matrix and Tb 0.025–0.25%, Ho 0.05–0.5%, Er 0.008–0.5%, and Y 0.03–0.8% in Dy_2O_3 matrix. (auth)

22090 (BLG-248) DETERMINATION DE L'ACTIVITE SPECIFIQUE DE L'IODE-131 SANS ENTRAINEUR ISOTOPIQUE (Determination of the Specific Activity of Carrier-Free Iodine-131). R. Constant (Centre d'Étude de l'Énergie Nucléaire, Brussels (Belgium)). [1964]. 8p. Dep.(mn).

The specific activity of a carrier-free iodine solution cannot be deduced by a simple calculation, as such a solu-

tion always contains iodine coming from the reagents used and iodine formed at the same time as iodine-131 during the irradiation of natural tellurium. It is necessary to devise an analytical process applicable to low iodine contents in presence of large quantities of thiosulfate; this process must also be simple on account of the high toxicity of iodine-131. The method proposed consists in making a photometric determination in the uv spectrum of the triiodide ion formed during chemical reactions, which in fact allows one to work on a solution containing six times more iodine. Afterwards, the sample is measured in an ionization chamber. A formula giving the specific activity in C/g is included. (auth)

22091 (COO-712-89) APPLICATION OF ALPHA-PARTICLE SCATTERING TO CHEMICAL ANALYSIS. R. A. Semmler, J. F. Tribby, and J. E. Brugger (Chicago Univ., Ill. Labs. for Applied Sciences). Oct. 1964. Contract AT(11-1)-712. 89p, Dep.; $3.00(cy), 2(mn) CFSTI.

The application of elastic backscattering of low energy (6.1 Mev) alpha particles to the chemical analysis of surface layers and thin film samples was examined. The sensitivity for light elements is greater than predicted from classical Rutherford scattering because of resonance scattering effects. Using a 1 mC alpha source the minimum detectable thickness-density for most elements is 2-10 $\mu g/cm^2$ using sample areas of about 4 cm^2 and counting times of 1000 minutes. Carbon is exceptional in that 0.2 $\mu g/cm^2$ can be detected. 69 references are included. (auth)

22092 (IS-T-6) COMPUTER SOLUTION OF SOLVENT EXTRACTION CASCADE CALCULATIONS FOR THE RARE-EARTH NITRATE-TBP-NITRIC ACID SYSTEM (thesis). Roger Frank Sebenik (Ames Lab., Iowa State Univ. of Science and Tech.). Feb. 1965. Contract W-7405-82. 73p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A digital computer program was written for the IBM 7074 that makes it possible to carry out trial-and-error calculations for a cascade of ideal solvent extraction stages with the feed stream entering an internal stage for the system $La(NO_3)_3-Pr(NO_3)_3-Nd(NO_3)_3-Sm(NO_3)_3-HNO_3-H_2O-TBP$. The program was tested using a number of different assumed values of starting conditions and no difficulties were experienced as long as the compositions remained in ranges for which the equilibrium data were valid. The precision of the match of compositions obtained at the predetermined point (aqueous phase leaving the feed stage as an example) could be made to be better than the normal accuracy of chemical analysis. (auth)

22093 (JINR-P-2000) IZUCHENIE KOMPLEKSOOBRAZOVANIYA AMERITSIYA I PROMETIYA EKSTRAKTSIONNYM METODOM. (Investigation of Complexes of Americium and Promethium Using Solvent Extraction). I. Stary (Joint Inst. for Nuclear Research, Dubna (USSR), Lab. of Nuclear Reactions). 1965. 10p. Dep.(mn).

The extraction constant of americium (log K = −7.48) and promethium (log K = −7.82) with thenoyltrifluoracetone (solvent-benzene) was determined. Further the composition and stability constants of complexes of americium and promethium with tartaric acid (log β_1 = 3.9; log β_2 = 6.8), oxalic acid (log β_2 = 8.3; log β_3 = 11.8), nitrilotriacetic acid (log β_2 = 19.71 for Am; log β_2 = 19.74 for Pm), ethylenediaminetetraacetic acid (log β_1 = 16.91 for Am and log β_1 = 16.94 for Pm) and 1,2-diaminecyclohexanetetraacetic acid (log β_1 = 18.21 for Am and log β_1 = 18.17 for Pm) were determined. From the results it was found that the stability constants of americium are closer to promethium than to europium. (auth)

22094 (LA-3248) THE SPECTROPHOTOMETRIC DETERMINATION OF TRACE AMOUNTS OF GALLIUM IN HIGH-PURITY PLUTONIUM METAL. Ross D. Gardner, Charles T. Apel, and William H. Ashley (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Feb. 1965. Contract W-7405-eng-36. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The rhodamine B method for the spectrophotometric determination of gallium was modified and applied to the determination of trace amounts of gallium in high-purity electrolytic plutonium metal. In this method the plutonium is dissolved in hydrochloric acid and the chlorogallate-rhodamine B complex is extracted into a 3:1 mixture of chlorobenzene and carbon tetrachloride without any preliminary separation of the plutonium. The absorbance of the extract is measured at 562 mμ. Forty-two determinations made on plutonium solutions containing from 0.5 to 100 ppm of gallium showed a standard deviation of 2% relative or 0.1 ppm, whichever was larger. Some care is necessary to assure that the volume and acidity of the aqueous phase is reproduced each time, but the manipulations are simple and little time is required. Interference from plutonium and from other elements commonly found in high-purity plutonium metal was found to be negligible. (auth)

22095 (MIT-905-10) RADIOCHEMICAL SEPARATION OF TIN AND ANTIMONY BY AN INITIAL PHOSPHATE PRECIPITATION STEP. M. P. Menon, N. K. Aras, and J. W. Irvine, Jr. (Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry and Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). [June 8, 1964]. Contract AT(30-1)-905. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A procedure for the separation of tin and antimony from fission product mixtures, using the difference in the precipitation behavior of tin and antimony phosphates, is presented. Although the radiochemical purification of tin is performed by procedures similar to those reported in the literature, antimony is essentially purified by the stibine method, using $NaBH_4$ as a reducing agent for the stibine generation. Chemical yields of 60 to 70% are obtained for both tin and antimony, and the decontamination factors are, in general, of the order of 10^3. (auth)

22096 (ORNL-3776(p.3-17)) INVESTIGATION OF THE IDENTITY OR CHARACTER OF VAPOR FORMS OF RADIOIODINE. (Oak Ridge National Lab., Tenn.).

By applying an adaptation of the Knudsen effusion method, the molecular weight of a radioiodine vapor species which sublimed at −78°C was determined to be about 145, corresponding to that of methyl iodide. Identification of volatile iodine compounds was also undertaken by the use of gas chromatography, making proper comparisons with known standards. A volatile fraction of radioiodine (sublimed at −78°C) was shown to be mostly methyl iodide, with traces of propyl iodide and hydrogen iodide. The response of composite diffusion tubes was studied using known vapors of elemental iodine and methyl iodide. The results indicate that elemental iodine deposits in Ag-lined diffusion tubes and that methyl iodide flows through the Ag-lined tube and deposits in the activated-carbon-lined tube. Samples of ^{127}I labeled with ^{131}I were prepared from palladium iodide and fractionally sublimed at temperatures of −78, −66, −58, −40, −7, and +10°C. The relative intensities of the mass peaks observed in the various fractions were compared with those in methyl iodide and hydrogen iodide standards. In all samples the prominent mass peaks could be accounted for by iodine, methyl iodide, and hydrogen iodide. The higher relative intensities of peaks corresponding to methyl iodide were found in the sample sublimed at −78°C. Deposition profiles of those iodine compounds which deposit on rubber in composite diffusion tubes indicated that at least two compounds are probably involved; the deposition behavior is complex and not solely diffusion controlled; one of the compounds may be unstable, and part of the deposition profile thereby may be the manifestation of a decomposition product. At 0°C the bulk of the species has an indicated vapor pressure about 1% that of elemental iodine. (auth)

22097 (ORNL-P-1127) THE EVALUATION OF COMPUTER PROGRAMS FOR γ-RAY SPECTROMETRY IN ACTIVATION ANALYSIS. J. F. Emery, F. F. Dyer, T. Alexander, and E. Schonfeld (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 17p. (CONF-650405-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Conference on Modern Trends in Activation Analysis, College Station, Tex.

Three operational computer programs for resolving

gamma-ray spectral data were evaluated. Two of these programs use linear least squares methods and the third, a nonlinear least squares method for resolving the spectra. Some problems considered are: ability to make gain shift corrections, the effect of zero activity nuclides on other nuclides present, and the significance and reliability of computed standard deviations. Results are presented for a series of samples with five replicates each analyzed by the three programs. Computer programs for resolving gamma spectra require a number of computer control data, such as peak channel, gamma-ray energies, gain shift, et al. The number and complexity of this control information depends largely upon the versatility of the program and upon the purpose for which the program was designed. Each of these programs was evaluated for its simplicity of use with a large number of samples. The computer cost per analysis for each program was also determined. (P.C.H.)

22098 (ORNL-TM-1047(p.69-71)) PROTACTINIUM-231 AND URANIUM-232. D. E. Ferguson (Oak Ridge National Lab., Tenn.).

Methods for the separation of protactinium-231 and the production of uranium-232 are discussed. The scarcity of ^{231}Pa is stressed. Uranium-232 is prepared by neutron irradiation of ^{231}Pa. Although only 17 mg of uranium pure material is presently on hand in the research pool, another 100 mg can be obtained by reprocessing raffinates. Approximately 10 mg of ^{228}Th per year may be prepared by milking large samples of ^{232}U periodically. (P.C.H.)

22099 (ORNL-TM-1058) THE EFFECT OF AN INERT DILUENT (HEXANE) ON THE DISTRIBUTION COEFFICIENTS OF ^{99m}Tc AND ^{131}I IN METHYL ETHYL KETONE/WATER AND METHYL ETHYL KETONE/2 M NH_4OH. J. J. Pinajian (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The extraction of ^{99m}Tc and ^{131}I from methyl ethyl ketone–hexane solutions into water and 2M NH_4OH was measured as a function of the concentration of methyl ethyl ketone. At 20–30% methyl ethyl ketone in hexane the distribution coefficient, K_d, for ^{99m}Tc in the methyl ethyl ketone–water system showed a minimum of $\sim 6 \times 10^{-5}$ and for the methyl ethyl ketone–2M NH_4OH system, a K_d minimum of $\sim 6 \times 10^{-4}$. For ^{131}I, the corresponding K_d's were ~13 and ~0.5, respectively. (auth)

22100 (ORNL-TM-1059) THE EXTRACTION OF INDIUM FROM HYDROCHLORIC ACID SOLUTIONS WITH n-AMYL AND n-OCTYL ALCOHOL AND ITS POSSIBLE USE FOR SEPARATING TIN AND INDIUM. K. R. Balasubramaniam and J. J. Pinajian (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 8p. Dep. (mn); $1.00(cy), 1(mn) CFSTI.

The n-amyl alcohol and n-octyl alcohol extraction of indium from hydrochloric acid solutions was investigated as a function of the acid concentration using ^{113m}In. Equilibrium time was found to be <2 min; K_d values for n-amyl alcohol of 0.02, 0.048, 0.075, 0.12, and 0.15 were established for 2, 4, 6, 8, and 12M HCl, respectively; for n-ocytl alcohol, K_d values of 0.06, 0.09, and 0.11 for 2, 4, and 6M HCl, respectively. The results showed that 9.4, obtained with n-amyl alcohol and 4M HCl, is the maximum separation factor for this method of separating tin and indium. (auth)

22101 (RFP-456) A MULTIPURPOSE GAS CELL. O. H. Willoughby, E. Vejvoda, and A. J. Johnson (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Apr. 7, 1965. Contract AT(29-1)-1106. 2p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A special gas cell was designed and fabricated to permit multi-correlation of infrared, gas chromatographic, and mass spectrometric analyses. Five of the cells have been in use for almost one year and have proven highly successful. (P.C.H.)

22102 (TIM-900) STATUS OF METHODS FOR DETERMINING CARBON, OXYGEN AND NITROGEN IN ALKALI METALS. E. W. Hobart (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). Apr. 1, 1965. Contract AT(30-1)-2789. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A critical review is presented of methods which have been proposed for determining carbon, oxygen, and nitrogen in alkali metals. Consideration of the assumptions inherent in each of the proposed methods reveals that inadequate knowledge of chemical reactions in alkali metal media is the chief reason for the present unsatisfactory status of alkali metal analysis. Research to achieve an understanding of the alkali metal–C–N–O system is recommended as a prerequisite to the development of valid analytical methods. (auth)

22103 (TIM-904) GENERAL METHOD FOR ANALYZING REFRACTORY METAL ALLOYS USING THE VACUUM CUP ELECTRODE. Elizabeth C. Leao, E. W. Hobart, and D. E. Fornwalt (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). [1963]. Contract AT(30-1)-2789. 30p. (CONF-650311-1). Dep. (mn); $2.00(cy), 1(mn) CFSTI.

From Conference on Analytical Chemistry and Applied Spectroscopy, Pittsburgh.

The application of the vacuum cup electrode to the spectrographic analysis of solutions of refractory metal alloys is described. Both citric and oxalic acids in five percent sulfuric acid solution served as suitable complexing agents. The absence of interelement effects is demonstrated. Alternate sets of excitation parameters and variation of sample weight and aliquot sizes permit application of the technique to a broad range of element concentrations. Typical coefficients of variation of results obtained by the method are between 3 and 4%. (auth)

22104 (UCRL-12253) IMPURITY REMOVAL BY DISTILLATION OF BERYLLIUM FROM THE SOLID STATE. R. F. Bunshah (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 4, 1965. Contract W-7405-eng-48. 17p. (CONF-650508-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Conference on Beryllium Metallurgy, Grenoble, France.

Beryllium was distilled from solid distillands of four widely varying compositions. The impurity content of the metallic elements in the distillate was compared to calculated values. Good agreement resulted for Fe, Ni, Cr, and Cu, fair agreement for Al, and poor agreement for Si, which apparently exhibited a positive deviation from Raoult's law behavior. No comparisons could be made for Ca, Mg, Na, and Mn because they reevaporated from the distillate that was collected at a very high temperature, ~1050°C. (auth)

22105 SEPARATION AND DETERMINATION OF RARE EARTH METALS BY ION EXCHANGE CHROMATOGRAPHY. I. PHOTOMETRIC DETERMINATION OF RARE EARTH IONS. Janos Inczedy, Gabor Nemeshegyi, and Laszlo Erdey (Technical Univ., Budapest). Acta Chim. Acad. Sci. Hung., 43: 1-7(1965).

A photometric procedure is described for the determination of small amounts of rare earth ions. The basis of the method is a color reaction, which takes place when a mixture of copper(II)-EDTA, ethanolic PAN indicator solution, and a lactic acid buffer (p_H 3 to 5) are added to the rare earth ion. The color reaction is shown by all the rare earths. (auth)

22106 FERROUS METALLURGY. H. F. Beeghly and L. C. Pasztor (Jones and Laughlin Steel Corp., Pittsburgh). Anal. Chem., 37: 87R-92R (Apr. 1965).

The determination of various elements in iron and the methods used are reviewed. 240 references are included for the period June 1962 to Sept. 1964. (P.C.H.)

22107 NONFERROUS METALLURGY. I. LIGHT METALS. Fritz Will, III (Aluminum Co. of America, New Kensington, Penna.). Anal. Chem., 37: 92R-103R (Apr. 1965).

The determination of various elements in Al, Be, Ti, and

Mg and their alloys by activation, atomic absorption, chemical methods, colorimetry, flame photometry, polarography, spectrography, and x-ray analysis is reviewed. 214 references are given for the period Sept. 1962 to August 1964. (P.C.H.)

22108 NONFERROUS METALLURGY. II. ZIRCONIUM, HAFNIUM, VANADIUM, NIOBIUM, TANTALUM, CHROMIUM, MOLYBDENUM, AND TUNGSTEN. Robert Z. Bachman and Charles V. Banks (Iowa State Univ., Ames). Anal. Chem., 37: 103R-17R(Apr. 1965). (IS-1080)

Methods for the determination of Zr, Hf, V, Nb, Ta, Cr, Mo, and W are reviewed. The methods include: spectrophotometry; optical methods; titrimetric methods; gravimetric methods; electrometry; spectrochemical methods; x-ray fluorescence analysis; neutron activation analysis; radiochemical analysis; and other methods. 294 references are given for the period Jan. 1962 to July 1964. (P.C.H.)

22109 VACUUM FUSION AND VACUUM EXTRACTION ANALYSIS FOR NITROGEN IN METALS. BASIC PRINCIPLES AND CURRENT STATUS. G. W. Goward (Pratt and Whitney Aircraft, North Haven, Conn.). Anal. Chem., 37: 117R-130R(Apr. 1965).

The vacuum fusion method for the determination of nitrogen in metals was re-examined, principally in terms of reaction mechanisms in the vacuum fusion process, and comparison of the results obtained by this method were compared with those from other methods. The review is limited to reactive and refractory metals and steels. Some consideration is also given to hot vacuum extraction (without fusion). Limited discussion is also given on the state and solubility of nitrogen in the reactive and refractory metals and steels. 47 references are cited. (P.C.H.)

22110 WATER ANALYSIS. M. W. Skougstad and M. J. Fishman (Geological Survey, Denver). Anal. Chem., 37: 232R-260R(Apr. 1965).

Methods and techniques for the analysis of water for alkali metals, alkaline earth metals, various other elements and compounds, gases, detergents, pesticides and herbicides, organics, radioactivity, and other substances are reviewed. 574 references are given for the period Oct. 1962 through Sept. 1964. (P.C.H.)

22111 HIGH-SENSITIVITY CONTROLLED-POTENTIAL COULOMETRIC TITRATOR. CONTROLLED-POTENTIAL COULOMETRIC DETERMINATION OF MILLI- AND MICROGRAM QUANTITIES OF URANIUM AND IRON. H. C. Jones, W. D. Shults, and J. M. Dale (Oak Ridge National Lab., Tenn.). Anal. Chem., 37: 680-7(May 1965). (ORNL-P-733)

An instrument was built specifically for the potentiostatic coulometric determination of small amounts (~0.010 to 100 μeq.) of materials. Emphasis was placed on careful construction using unmodified amplifiers and conventional circuitry. Precise calibration circuitry was incorporated into the instrument for convenience and also to provide a source of easily adjusted constant current for other electroanalytical applications. The instrument was tested with and used for the determination of milli- and microgram quantities of iron and uranium over a period of several years. The procedures used for these determinations involve both reversible and irreversible systems, the use of either mercury or platinum as the controlled electrode, and both reduction and oxidation electrolyses. They are therefore representative of the procedures that are most often encountered in controlled-potential coulometry. The instrument and procedures are described and typical analytical results are presented. (auth)

22112 SEPARATION OF BERKELIUM FROM OTHER ELEMENTS. APPLICATION TO PURIFICATION AND RADIOCHEMICAL DETERMINATION OF BERKELIUM. Fletcher L. Moore and W. Thomas Mullins (Oak Ridge National Lab., Tenn.). Anal. Chem., 37: 687-9(May 1965).

A simple analytical radiochemical method for the purification and determination of berkelium tracer is based on a two-cycle liquid–liquid extraction system. Berkelium(IV) is extracted into 0.15M di(2-ethylhexyl)-orthophosphoric acid-heptane from 10M nitric acid followed by reduction and stripping into 11.8M lithium chloride–0.4M hydrochloric acid solution. Thirty per cent tricaprylamine–xylene is used in the second cycle to separate berkelium(III) from cerium(III) and to increase the decontamination from other elements. Excellent separation is effected from many elements including uranium, neptunium, plutonium, americium, curium, californium, lanthanide elements, cesium, strontium, barium, zirconium, niobium, ruthenium, nickel, iron, aluminum, silver, and molybdenum. Several useful analytical and process applications of this purification method are discussed. (auth)

22113 X-RAY FLUORESCENCE DETERMINATION OF STRONTIUM IN BIOLOGIC MATERIALS BY DIRECT MATRIX-TRANSMITTANCE CORRECTION. Marvin Goldman and R. P. Anderson (Univ. of California, Davis). Anal. Chem., 37: 718-21(May 1965). (TID-21558)

A quantitative method for strontium x-ray fluorescence determination in food and bone is described for weighed specimens mixed and briquetted with organic binders. Transmittance of the briquets as measured with monochromatic Sr Kα radiation provides accurate corrections for the Sr Kα emission of fluorescent x rays derived from specimens of differing x-ray opacity. Specimens from 0.050 to 2 g containing from 20 to 2000 μg of Sr per gram were analyzed and showed the emergent fluorescent x-ray intensity to be linearly related to the transmittance of the briquet. Rapid quantitation of Sr can thus be performed on dry samples without prior knowledge of matrix composition with an expected relative error of less than 5%. (auth)

22114 THEORY AND EXPERIMENT IN RAPID, SENSITIVE HELIUM-3 ACTIVATION ANALYSIS. HELIUM-3 REACTIONS AS NEUTRON SOURCES. Enzo Ricci and R. L. Hahn (Oak Ridge National Lab., Tenn.). Anal. Chem., 37: 742-8(May 1965). (ORNL-P-989)

A general mathematical treatment was developed that reduces charged-particle activation analysis of thick samples to almost the simplicity of neutron activation. To determine the detection limits for beryllium, carbon, nitrogen, oxygen, and fluorine, thick and thin targets were irradiated with 5- and 10-Mev ^{3}He ions. The results showed that these elements can be easily detected in the concentration range of parts per billion. In particular, oxygen can be rapidly determined with high sensitivity by assaying 2-minute ^{15}O. Curves of detection limits for oxygen vs. range and atomic number are given for several reactions. The neutron outputs from reactions of 10-Mev ^{3}He particles with lithium, beryllium, and boron were measured and compare favorably with those from (d + t) reactions in conventional neutron generators. Furthermore, the neutron yields from ^{3}He irradiations did not decrease with target usage. The yield of high-energy γ rays (~20 Mev) was also significant. These results suggested that a small cyclotron, built for ^{3}He-activation analysis, could be effectively used for fast-neutron and photon activation analysis. (auth)

22115 ELIMINATION OF CONTAINER EFFECTS IN ACTIVATION ANALYSIS OF OXYGEN. K. G. Broadhead and H. H. Heady (Bureau of Mines, Reno, Nev.). Anal. Chem., 37: 759-60(May 1965).

A major difficulty in determining trace amounts of oxygen in metals is the problem of correcting for background due to sample container, atmosphere in the container, and normal gamma radiation to which the scintillation detector is exposed. A procedure was developed in which the metal sample was activated in a plastic container, but removed therefrom and dropped into the scintillation detector. The total delay time prior to counting is increased from 3.0 to 4.5 sec by the manual operation. However, the delay is more than offset by the elimination of all background except that due to normal room background. (M.C.G.)

22116 FLUOROMETRIC DETERMINATION OF MICROQUANTITIES OF URANIUM IN MIXTURES OF URANIUM AND PLUTONIUM. Robert A. Jaroszeski and Charles C. Gregg (United Nuclear Corp., White Plains, N. Y.). Anal. Chem., 37: 766(May 1965).

A study was made to determine whether the fluorometric method could be applied to uranium determination in uranium–plutonium mixtures without preliminary separation of plutonium. It was found that microquantities of uranium can be determined by the fluorometric method in mixtures with U:Pu ratios as high as 1:20. (M.C.G.)

22117 DETERMINATION OF OXYGEN IN URANIUM DICARBIDE BEADS HAVING HIGHLY IMPERVIOUS PYROLYTIC CARBON COATINGS. M. E. Smith, J. M. Hansel, and G. R. Waterbury (Los Alamos Scientific Lab., N. Mex.). Anal. Chem., 37: 782-4(May 1965). (LA-DC-6505)

A sample handling device is described for crushing and loading materials into a crucible within an inert atmosphere of a furnace, which is an integral part of an inert carrier gas apparatus for determining oxygen. The crushing operation is prerequisite to the satisfactory release of oxygen at 2600°C from UC beads with highly impervious pyrolytic carbon coatings. Operation of the sample handling device is shown schematically. Tests indicated that the cores are effectively exposed by the crushing operation. (M.C.G.)

22118 INORGANIC SCINTILLATORS FOR MEASURING ^{14}C AND ^{3}H IN COLUMN RADIOCHROMATOGRAPHIC FLOW CELLS. H. W. Scharpenseel and F. Pietig (Universitat, Bonn). Atompraxis, 11: 98-101(Feb. 1965). (In German)

Various inorganic scintillators based on Ag-activated ZnS, calcium tungstate, and Ce-activated glass containing lithium were tested for measurement yield and usability as fillers for flow cells with organic elution substances in column radiochromatography. As fillers for flow cells, the preparations CWR (calcium tungstate), Blue R, and ZnS (Ag-activated ZnS + Ni for shortening the after-glow time) all had a measurement yield of 1.9 to 2.6% for ^{14}C and 0.2 to 0.27% for ^{3}H. Thus they can be used successfully for charges from 10^{-2} μc onward for ^{14}C, and from 10^{-1} μc onward for ^{3}H, in column radiochromatographic separation and registration. Ce-activated glass powder (grain size 0.25 to 0.35 mm) containing 2.5% lithium showed a somewhat lower measurement yield of 1.6% for ^{14}C and 0.12% for ^{3}H, depending upon the grain size. It has particular advantages due to its high permeability and independence from memory effects. (auth)

22119 RADIOCHEMICAL METHODS OF ANALYSIS. L. Wiesner (Kernforschungszentrum. Karlsruhe, Ger.). Atomwirtschaft, 10: 131-3(Mar. 1965). (In German).

The present state of radiochemical methods of analysis is discussed. An evaluation of the rapid progress of these methods indicated that their advantages will lead to the possibility of their addition to the routine techniques available even to industrial laboratories. Practical utilization of activation analysis, the analytical application of radioactive tracers, and the use in analysis of radioactive sources of radiation are discussed. It is shown that in some cases the same end can be achieved with a much reduced expenditure of both time and money by using a tracer method orientated to the specific problem rather than activation analysis. Improvements to x-ray fluorescence analysis using radioactive sources of radiation are considered. (auth)

22120 A UNIVERSAL SEMI-QUANTITATIVE SPECTROCHEMICAL METHOD FOR THE ANALYSIS OF POWDERED SAMPLES. Momir Marinkovic. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 111-24(July 1963).

A simple spectrochemical semi-quantitative method for the analysis of powder samples for some thirty elements which can be detected in a d-c arc, is described. The use of Li_2CO_3 as a spectrographic buffer allows only one series of standard samples to be used for the analysis of materials with various matrices. The analytical procedure covers a concentration range of 0.1 to 100% for the majority of elements, and of 0.01 to 100% for some elements of greater spectrochemical detectability in a d-c arc, such as: Al, Ag, Ba, Bi, Be, Ca, Co, Cr, Cu, Fe, Mo, Mn, Ni, Si, and V. Germanium is used as an internal standard. The intensity of spectral lines is estimated visually by counting the visible steps of a line on the spectrogram photographed through the rotating step-sector. The mean deviation of a single determination is usually about 30%. In some cases it reaches a factor of 2. Analysis by the procedure described requires slightly more time than the corresponding qualitative analysis. (auth)

22121 SPECTROPHOTOMETRIC DETERMINATION OF THORIUM(IV) WITH XYLENOL ORANGE AND METHYLTHYMOL BLUE. Makoto Otomo (Hachinohe Technical Coll., Aomori, Japan). Bunseki Kagaku, 14: 229-35(Mar. 1965). (In Japanese)

Sensitive reactions of thorium(IV) with xylenol orange (XO) and methylthymol blue (MTB) were applied to the spectrophotometric determination of thorium. The effects of pH, amount of reagent, and standing time on the color development were investigated, and the optimum conditions for the determination were established. When 1 to 2 complexes between thorium and the reagents were used, 0.2 to 2.8 and 0.4 to 4 ppm of thorium could be determined with XO and MTB, respectively. It was found by applying the method of continuous variations that thorium(IV) reacted with XO and MTB to form two complexes, 1 to 1 and 1 to 2 (metal to reagent), depending on the pH of the solution. The apparent and the true formation constants of 1 to 2 complexes were calculated. (auth)

22122 ONE USEFUL METHOD IN ACTIVATION ANALYSIS. DETERMINATION OF IMPURITIES IN YTTRIUM. Toshi Kawashima (Electrical Communication Lab., Tokyo). Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokoku, 13: 1835-43(Nov. 1964). (In Japanese)

A method of activation analysis is described in which, in the determination of dysprosium in yttrium oxide, the yttrium is used as the internal standard. The internal standard method, in which the amount of impurity was determined from the activity intensity ratio of the main component and impurity component, was found to be useful as one method of activation analysis. The results obtained were compared with those from gamma spectrometry and absorption photometry, and it was found that the method was very effective. The standard deviation in the method is about 10%. In sample materials measured, were about 30% higher than those obtained by the gamma spectrometry; this is being studied further. It was concluded that internal standard method is more efficient in irradiation with particle rays than in reactor irradiation. (NSA of Japan)

22123 A TENTATIVE APPLICATION OF THE ISOTOPIC ANALYSIS OF SULFIDE SULFUR FROM GOLD-ORE DEPOSITS OF THE BALEISK REGION (EASTERN TRANSBAIKAL). L. N. Grinenko, M. G. Andreeva, and A. M. Gavrilov (Central Scientific Research Inst. of Mining and Prospecting of Rare, Disseminated and Precious Metals, Moscow). Geokhimiya, No. 3, 325-36(Mar. 1965). (In Russian)

Determination of the isotopic composition of sulfide sulfur from deposits and ore mainifestations of the Baleisk ore field allowed separate groups of sulfides differing by their isotopic composition and by the time of their formation to be determined. It is suggested that the differences in isotopic sulfur composition of separate sulfide groups is conditioned by the formation of a sulfide mineralization from various crustal sources. (auth)

22124 APPLICATION OF QUALITY CONTROL PROCEDURES TO ENVIRONMENTAL RADIOASSAY—IODINE-131 IN MILK. Marvin Rosenstein and A. S. Goldin (Dept. of Health, Education, and Welfare, Winchester, Mass.). Health Phys., 11: 297-305(Apr. 1965).

In a widespread surveillance program of environmental radioactivity such as that carried out by the Division of Radiological Health, U. S. Public Health Service, reliability of analytical data is of primary importance if measurements by different laboratories are to be comparable and valid. This paper describes the application of quality control techniques to the analysis of samples of fluid milk. The specific technique used for examining the data was the control chart, which was applied to samples of known radionuclide content. This technique facilitated the study of

the analytical data so that laboratories producing divergent data could be identified and corrective measures instituted. As practiced under this program, specially prepared samples of milk with known iodine-131 concentrations were analyzed by the laboratories in their routine manner, and the resulting analytical data were statistically compared with the expected values. Control charts were so constructed as to determine whether the accuracy, including precision and bias, of reported results met empirically selected criteria. Through periodic submission of samples, the control-chart method produced a record of laboratory response to quality control efforts. Data depicting the improvement of laboratory agreement with known values, for two sets of samples submitted several months apart, illustrate the usefulness of this quality control measure. (auth)

22125 A COLD STRIP APPARATUS FOR SAMPLING TRITIUM IN AIR. T. S. Iyengar, S. H. Sadarangani, S. Somasundaram, and P. K. Vaze (Atomic Energy Establishment, Trombay, India). Health Phys., 11: 313-14(Apr. 1965).

An apparatus for sampling tritium in air is described. It consists of an Al strip immersed in a liquid N bath and extending well into the atmosphere to be sampled. Water droplets and CO_2 from the atmosphere condense on to the upper part of the cold strip and the water droplets trickle down into a flask. The specific activity of tritium in the aqueous sample is estimated. A hygrometer placed beside the cold strip apparatus records the humidity and temperature of the air during the time of collection. The tritium content of the sampled air is calculated from data on the moisture content and activity of the aqueous sample. (C.H.)

22126 STUDIES ON THE BEHAVIOR OF TRACE HEAVY METALS IN SILICON CRYSTAL BY NEUTRON ACTIVATION ANALYSIS. Tetsuo Kusugi and Takuzo Ogawa (Hitachi, Ltd., Tokyo). Hitachi Hyoron, 46: No. 9, 1-5(Sept. 1964). (In Japanese)

Contamination of silicon crystals by trace heavy metals in the production process was studied by neutron activation analysis. Sources of contamination and the behavior of impurity metals during the acid washing were observed. The heavy metal impurities contaminating the silicon were mainly gold, copper, and iron. Copper and iron could be removed by washing with acid; however, gold was difficult to remove completely. Equations expressing the relation between the gold absorbed and its concentrations in hydrofluoric acid and in aqua regia solution were derived. (NSA of Japan)

22127 SPECTROPHOTOMETRIC DETERMINATION OF CERIUM(IV) WITH SALICYLHYDROXAMIC ACID. S. N. Poddar, N. R. Sengupta, and J. N. Adhya (Indian Assn. for the Cultivation of Science, Calcutta). Indian J. Pure Appl. Phys., 3: 135-6(Mar. 1965).

A spectrophotometric method for the determination of micro amounts (up to 4 ppm) of Ce(IV) is described. Cerium(IV) forms a soluble reddish brown complex with salicylhydroxamic acid between pH 9.4 and 10.2 with an absorption maximum at 430 mμ. The color of the complex obeys Beer's law up to a concentration of 19.6 ppm of the metal ion. The composition of the complex reveals a 2:1 ligand-metal ratio. (auth)

22128 MICROSCOPIC DETERMINATION OF BONE PHOSPHORUS BY QUANTITATIVE AUTORADIOGRAPHY OF NEUTRON-ACTIVATED SECTIONS. Jacques Vincent, Stanislas Haumont, and Joseph Roels (Louvanium Univ., and TRICO Centre, Leopoldville, Belgian Congo). J. Cell Biol., 24: 31-7(Jan. 1965).

Longitudinal sections of human cortical bone were submitted to thermal neutrons. γ-ray spectra were recorded repeatedly during 15 days following irradiation. They showed that ^{24}Na is predominant as early as 3 hours after activation and that all the γ-emitters have decayed on the 15th day. When the γ-rays have disappeared, β-rays are still produced by the sections. It was proved by the absorption curve in aluminium that all these β-rays are issued from the ^{32}P induced in the sections by activation of ^{31}P. Therefore autoradiograms registered 15 days after activation reveal the distribution of ^{32}P in the sections. γ-ray spectra and β-ray absorption curves of neutron activated sections of ivory demonstrated a mineral composition similar to that of bone. Autoradiograms of ivory sections activated for various times were used to establish the relation between the optical density of the autoradiograms and the radioactivity in ^{32}P. When the bone autoradiograms are compared with the ivory standards of known radioactivity, the optical densities of single osteons (Haversian systems), can be related to their phosphorus contents. Autoradiograms and microradiograms of the same sections were examined side by side. The least calcified osteons, that contain 80 per cent of the calcium of the fully calcified osteons, also contain about 80 per cent of the phosphorus of the fully mineralized osteons. It is concluded that the Ca:P ratio remains constant while mineralization of bone tissue is being completed. (auth)

22129 RADIOCHEMICAL SEPARATION OF THALLIUM FROM THORIUM BY ANION EXCHANGE RESIN: A ^{208}Tl RESERVOIR. Alcidio Abrao (Instituto de Energia Atomica, Sao Paulo, Brazil). J. Chem. Educ., 41: 600-2(Nov. 1964).

A one-step procedure is described for isolating the short half life ^{208}Tl (3.1 min) from common Th salts. This experiment illustrates several important principles and useful techniques, such as the use of the natural radioactive series as a source of suitable and inexpensive radioisotopes, the use of an anionic exchange resin as a speeding up procedure for radiochemical separation, the measurement of short half lives, and the preparation of a radioisotope reservoir, from which the 3.1-min ^{208}Tl can be eluted many times successively. In the method described the separation of radiothallium is simple, clean, and rapid, taking less than one minute to carry out. The procedure is based on the principle that the anionic chloride bismuth complex is strongly held in an anionic exchange resin (Cl form), while Tl can be eluted from the resin with dilute HCl. The Tl(III) in HCl solution is held strongly by an anionic exchange resin, while Tl(I) is only weakly held. Thus, Tl is eluted in the (I) form. The column (one ml of Nalcite SAR resin) can be eluted each 5 to 10 min and supply ^{208}Tl for many experiments during a day. The column acts as a reservoir for ^{208}Tl extraction and the capacity of the reservoir decays with the 60.5-min half life of ^{212}Bi. The column is prepared by percolation of thorium chloride solution through it and washing it with 1.0M HCl. Simple elution of this column with 1.0M HCl furnishes a ^{208}Tl activity and typical composite decay curve. (TCO)

22130 CHEMICAL METHODS OF STUDY OF FREE RADICALS. J. B. Donnet and L. A. Libis (Ecole Superieure de Chimie, Mulhouse, France). J. Chim. Phys., 61: 1477-89(Nov.-Dec. 1964). (In French)

The principal chemical reactions that make it possible to show and determine the free radicals present in the gaseous, liquid, or solid phase are reported. A radiochemical method for the determination of the free radicals at the surface of a solid is illustrated by the results obtained utilizing ^{14}C-labeled azobisisobutyronitrile for the study of a surface of carbon black. (tr-auth)

22131 THIN-LAYER CHROMATOGRAPHY OF SOME ^{131}I AND ^{125}I LABELLED IODOPYRIMIDINES AND RELATED NUCLEOSIDES. A. Massaglia, U. Rosa, and S. Sosi (SORIN, Saluggia, Italy). J. Chromatog., 17: 316-21(Feb. 1965).

The separation of some radioiodinated pyrimidines and nucleosides of biological interest was studied by thin-layer chromatography. R_F values of iodouracil, iodocytosine, iodouridine, iododeoxyuridine, and iodocytidine on layers of silica gel G and cellulose G were measured for a number of solvents: n-butanol saturated with water, n-butanol saturated with 0.1N H_3BO_3, n-butanol saturated with 1N H_3BO_3, a saturated solution of H_3BO_3 in water, 0.1N HCOOH, n-butanol saturated with 0.1N HCOOH, and n-butanol saturated with 0.1N NH_4OH were used. With a proper choice of elution system and support, a very good resolution of the

single spots could be attained and the relative percentages of the labeled components in a sample could be evaluated with a negligible error by radioactive scanning of the chromatographic plate. (auth)

22132 A LIQUID SCINTILLATOR-BASED CONTINUOUS RADIO CHROMATOGRAM SCANNER. W. E. Sprott (Unilever Research Lab., Sharnbrook, Bedford, Eng.). J. Chromatog., 17: 355-61(Feb. 1965).

An instrument for the direct and continuous scanning of paper chromatograms carrying soft β emitters is described. The method of detection is based on a liquid scintillator with which the developed paper chromatograms are directly impregnated. The response is sufficiently linear to permit direct quantitative assay of radioactivity down to at least 0.1 nC of ^{14}C per spot of 5 cm^2 or more surface area and is not attenuated in thick papers. The design of the mechanical parts of the scanner reduces to a minimum the amount of precision machining required in its manufacture. (auth)

22133 ON THE POLAROGRAPHY OF TECHNETIUM. I. DIRECT CURRENT AND ALTERNATING CURRENT POLAROGRAPHIC INVESTIGATIONS OF PERTECHNETATE SOLUTIONS. L. Astheimer and K. Schwochau (Kernforschungsanlage, Julich, Ger. and Universitat, Cologne). J. Electroanal. Chem., 8: 382-9(Nov. 1964). (In German)

Neutral and alkaline solutions of $K^{99}TcO_4$ in the concentration range from 10^{-3} to 10^{-4}M were investigated polarographically with direct and alternating currents. Four steps and waves respectively were observed. The first two steps of $E_{\frac{1}{2}} \simeq -0.8$ and $\simeq -1.1$ v corresponded to electron transitions $n \simeq 2$ and $\simeq 3$, whereas the third and fourth steps were influenced by catalytic effects. It may be pointed out that reduction first to Tc(V) takes place not only in the alkaline but also in the neutral solutions. Alternating current efficiencies of 70 to 90% for the wave $E_{\frac{1}{2}} \simeq -0.8$ v were obtained as a function of the type and concentration of the supporting electrolyte. From this followed the possibility of a-c polarographic determination of technetium, which is advantageous because of its higher separation capacity in comparison to the d-c polarographic methods. (auth)

22134 DROP-TIME DEPENDENCE OF A.C. POLAROGRAPHIC PEAK HEIGHTS. G. H. Aylward and J. W. Hayes (Univ. of New South Wales, Kensington, Australia). J. Electroanal. Chem., 8: 442-8(Dec. 1964).

Experimental evidence of the drop-time dependence of the peak height in a-c polarography is presented for a quasi-reversible electron-transfer process and a number of reductions and oxidations involving coupled chemical reactions, rate limited surface coverage, and amalgam formation. Each process is discussed in relation to the kinetics of the overall electrode reaction. In the systems reported, drop-time dependence is exhibited whenever a form of mass transfer other than, or as well as, diffusion operates. (auth)

22135 POLAROGRAPHY OF U(IV) IN THE ETHANOL–WATER SYSTEMS. George Nolan, Jr., and Edward S. Amis (Univ. of Arkansas, Fayetteville). J. Polarog. Soc., 10: 7-16(1964). (TID-20409)

The polarography of the uranium(IV)-uranium(III) couple was studied in acid solutions of water, and of 30.0, 60.0, and 80.0 wt % ethanol-water at 25°C. In each of these solvents the couple was studied as a function of the uranium(IV) hydrogen ion, and chloride ion concentration. The couple was found to be reversible at the d.m.e. in water and in 30.0, 60.0, and 80.0 wt % ethanol-water media at acid concentrations at and above 0.05, 0.2, and 0.6M, respectively. In all the solvent media the half-wave potential was independent of the uranium(IV) concentration. At low chloride ion concentrations uranium(IV) and uranium(III) formed the same type of chloride complex in water and 30.0 wt % ethanol-water media. At higher chloride ion concentrations the difference in the number of chloride ligands around uranium(IV) and uranium(III) differed by one in water and by 0.60 in 30.0 wt % ethanol-water solvent. At all chloride ion concentrations U(IV) and U(III) formed the same type of chloride complex in 60.0 and 80.0 wt % ethanol-water media. In water and 30.0 wt % ethanol-water the half-wave potential shifted to more negative values with an increase in the acid concentration, whereas in 60.0 and 80.0 wt % ethanol-water media in half-wave potential shifted to more positive values with an increase in the acid concentration within a certain acid range. The product of the diffusion current constant and the square root of the viscosity coefficient $I\eta^{\frac{1}{2}}$ was fairly constant down to about 50.0 wt % ethanol-water solvent where it changed and remained fairly constant up to 80.0 wt % ethanol-water. The half-wave potential remained fairly constant down to this same percent solvent, where it shifted to more negative values and remained fairly constant. The effect of the hydrogen ion on the half-wave potential changed from 30.0 to 60.0 wt % ethanol. Within this same solvent range the nature of the complex of uranium(IV) and uranium(III) changed. It was concluded that these phenomena probably reflect a change in the molecular state of uranium(IV) and uranium(III). (auth)

22136 THE CURRENTLY USED METHODS OF RADIOCHEMICAL SEPARATION OF CESIUM-137 IN BLOOD AND LOW-BACKGROUND COUNTING WITH A 4π COUNTER. Noboru Yamagata (Inst. of Public Health, Tokyo). Koshu Eiseiin Kenkyu Hokoku, 13: 153-8(Sept. 1964).

The conventional method of radiochemical analysis of cesium-137 in biological materials, i.e., the combined dipicrylaminate-chloroplatinate method, improved for use in blood analysis by combining with ammonium molybdophosphate separation. A 4π thin-window flow counter was also developed to increase the sensitivity of β-counting and gave good performance when used for routine analysis. It has a sensitivity of about four times that of a conventional 2π counter. Procedures for radiochemical separation and β-counting are described. (auth)

22137 NEUTRON-ACTIVATION ANALYSIS IN MAN IN VIVO: A NEW TECHNIQUE IN MEDICAL INVESTIGATION. J. Anderson (King's Coll. Hospital, London), S. B. Osborn, R. W. S. Tomlinson, D. Newton, J. Rundo, L. Salmon, and J. W. Smith. Lancet, 2: 1201-5(Dec. 5, 1964).

Neutron-activation analysis was performed in vivo in two men using radiation doses small enough to be comparable with those used in diagnostic radiology. Preliminary calculations showed that a neutron exposure of about 0.1 rad (i.e., about 1 rem) produces about 0.01 μC ^{24}Na and 0.05 μC ^{38}Cl in man. Therefore, attempts were made to assess this technique using an exposure of about 0.1 rad. Approximate uniformity of irradiation throughout the body could be achieved for Na by using 14-Mev neutrons irradiating a subject covered with 3 cm of polyethylene as a partial moderator. A 68-kg phantom consisting of ten polyethylene vessels was used to calibrate the whole-body counter. It contained 59 l of a solution of 173 g NaCl and 137 g $NaNO_3$, corresponding to 105 g Na and 105 g Cl: these are the values given for the total-body contents of these elements in a 70-kg standard man. After measurement of his background body radioactivity, each subject was enclosed in polyethylene sheet 3 cm thick, about 1.1 m from the target of a Cockcroft-Walton neutron generator. Polyethylene bottles filled with water were placed beside his legs to reduce loss of slow neutrons, and slabs of polyethylene 3 cm thick were placed over him. A dose of 0.05 rad was delivered to the incident skin surface of the subject: he was then turned over and given a further 0.05 rad. His radioactivity was measured in a whole-body counter for about 35 min. Further measurements were made at about 5 hr (when the ^{38}Cl has decayed to about 0.3%) and at 24 hr. The phantom was irradiated under the same conditions. After the 24-hr measurement of whole-body radioactivity, the subject was injected with 1.5 ml of 0.9% NaCl solution which had just been activated to produce about 10 μC of ^{24}Na and 60 μC of ^{38}Cl. Blood samples were taken at intervals during the next 24 hr, and measurements of body radioactivity were made at about 1, 5, and 24 hr. The estimated total-body Na was similar (82 and 77 g) in the two subjects of different heights and weights. The exchangeable body Na, determined by isotope dilution, was 81 g in both subjects. Thus the results showed little dif-

ference between the total Na as determined by activation analysis in vivo and the exchangeable Na as determined by isotope dilution. These experiments were devised principally to study the Na and Cl contents of the subjects, and not elements which activate to radionuclides of shorter half life than ^{38}Cl (such as Ca). Thus the irradiations were not particularly short, the delays between irradiation and body-radioactivity measurement were not inconsiderable, and the duration of each measurement (17 min) was almost twice the half life of ^{49}Ca. Several shorter measurements of body radioactivity might be preferable to one or two longer ones, and accurate measurements of total body Ca could be made, using a phantom containing a dummy skeleton of known Ca content as a standard. This would be of considerable value in studies of various bone disorders and of the action of drugs. (BBB)

22138 MEASUREMENTS OF TRITIUM BY LIQUID SCINTILLATOR IN COINCIDENCE SYSTEM. Ferenc Koehegyi, Piroska Fodorne Csanyi, and Bela Levay (Eotvos Lorand Tudomanyegyetem Fizikai-Kemiai es Radiologiai Tanszeke, Budapest). Magy. Kem. Folyoirat, 67: 413-14 (Sept. 1961). (In Hungarian)

A coincidence circuit was applied to the measurement of tritium radiation with scintillation counters, and the photoelectron multiplier was heated to 15°C. The sample changer constructed made it possible to heat the preparation and to change the samples in the dark. The heat sensitivity of the photocathode was reduced with the use of light conductor. The sample changer and the coincidence device was calibrated with ^{137}Cs isotope. (tr-auth)

22139 DETERMINATION OF THE SULFUR CONTENT IN CARBOHYDRATES BY MEANS OF ABSORPTION OF TRITIUM BREMSSTRAHLUNG. Piroska Fodorne Csanyi, Gyoergy Horanyi, and Oliver Kaposi (Eotvos Lorand Tudomanyegyetem Fizikai-Kemiai es Radiologiai Tanszeke, Budapest). Magy. Kem. Folyoirat, 67: 491-5(Nov. 1961). (In Hungarian)

The sulfur content of carbohydrates was determined by absorption of the bremsstrahlung of tritium at 1.05 Å average wavelength. The absorption of solutions of known composition was measured and the mass absorption coefficient of carbon, hydrogen, and sulfur was determined by application of the Lambert-Beer law. The sulfur content of the mixture was established with the help of the determination of the mass absorption coefficients on the basis of the data obtained. The method was feasible for the determination of the sulfur contents of 0.5 to 3%. The accuracy could be compared with the best classical sulfur determination methods (0.02%). The time for measurement was much shorter; the installation was, however, much more expensive (than in the case of earlier methods), and the operation required a greater development. (tr-auth)

22140 CHEMICAL STUDY OF NATURAL RADIO-ELEMENTS. PART II. SEPARATION AND DETERMINATION OF RaC BY THE CUPFERRON–CHLOROFORM METHOD, AND THE RaC CONTENT IN THE MASUTOMI HOT SPRING. Takeshi Sugihara (Yamanashi Univ., Japan). Mem. Fac. Liberal Arts Educ., Yamanashi Univ., No. 14, 120-5(1963). (In Japanese)

A definite quantity of the sample water was added to a mixture of 5.0 ml 1% cupferron solution, 10N sulfuric acid, and 10.0 ml chloroform and the pH of the aqueous phase was adjusted to 1. After shaking vigorously for 1 min, the chloroform phase (which contained RaC) was separated, and an aliquot (2.0 ml) was pipetted into a counting vessel and evaporated to dryness. The activity was counted with a Lauritsen electroscope. With the mineral water samples in which Rn and RaC had reached equilibrium, RaC and Rn were determined respectively, and the relationship between their concentrations was obtained. A good reproducibility of the results was obtained. The influences on the RaC extractability into the chloroform of the volume of the sample mineral water, the quantity of cupferron added, the temperature, the shaking time, and the concentrations of the coexistent salts were investigated. The concentrations of RaC and Rn were determined by this process in the Masutomi hot spring (Yamanashi prefecture). The correlations between the temperature and the pH of the mineral water, the Rn concentration and the pH, the Rn and the RaC/Rn ratio, etc. are discussed. (NSA of Japan)

22141 LOW-TEMPERATURE FLUOROGRAPHY INDUCED BY TRITIUM-LABELLED COMPOUNDS ON THIN-LAYER CHROMATOGRAMS. Ursula Luethi and P. G. Waser (Univ. of Zurich). Nature, 205: 1190-1(Mar. 20, 1965).

A method is described for the application of fluorography to thin-layer chromatography of tritium-labeled compounds. Solid anthracene that is finely ground in a ball mill with an equal amount of silica gel G (content of gypsum 13%) to a crystal size of 1-5 μ is used as the scintillator. The method takes advantage of four properties of anthracene: its high fluorescence efficiency; the temperature dependence of its fluorescence intensity; its low solubility in most of the common solvents; and its low chemical reactivity. Low temperature during exposure is essential. It was concluded that the method could be improved by raising the ratio anthracene/silica gel. The purity of the anthracene is not of primary importance. (P.C.H.)

22142 HOW TO USE RADIOISOTOPES WITH THIN-LAYER CHROMATOGRAPHY. Nucl.-Chicago Tech. Bull., No. 16, 4p.(1963).

Some uses of thin-layer chromatography (TLC) for the analysis and purification of radioisotope-labeled compounds are summarized. Methods of preparing cromatoplates and radioactivity detection techniques are described. Quantitative determination of the various fractions can be effected by elution of the spots, direct counting of the radioactive spots, use of suspended scintillators, and autoradiography. The applications of TLC with indicator analysis, isotope dilution analysis, and isotope derivative methods is discussed. Applications of TLC in chemical and biochemical investigations, using radioisotopes, are reviewed. (54 references) (M.C.G.)

22143 GAS CHROMATOGRAPHY. J. C. Hawke and P. K. Stumpf (Univ. of California, Davis). Nucleus (Chicago), No. 18, 1-11(Feb. 1965).

Principles of gas-liquid chromatography are reviewed. The chromatographic column, sample application, chromatograph detectors, and sample collection are described. Measurement of the radioactivity of compounds separated by gas-liquid chromatography may be made either using fractions collected intermittently or by continuously assaying the chromatographic effluent. Intermittent collection was found to be advantageous if the radioactivity was low, because counting time could be adjusted to obtain the desired statistical significance. The continuous counting method frequently enabled a distinction to be made between trace components of low activity with similar retention values. Separation and determination of fatty acids and related compounds, steroids, carbohydrates, amines, and amino acids by gas-liquid chromatography are discussed. (124 references). (M.C.G.)

22144 A CURRENT-INTEGRATING GAMMA ABSORPTIOMETER AND DATA LOGGER FOR ROUTINE URANIUM ANALYSIS. Norman P. Wilburn and Wesley L. Nicholson (General Electric Co., Richland, Wash.). Talanta, 12: 305-25(Apr. 1965).

Uranium concentrations in aqueous and organic solutions can be determined by gamma absorptiometry. An ^{241}Am source, which emits photons of 60 kev, is used with a scintillation detector. The output current from the phototube is integrated for 1 min to give a 2 to 10 v d-c signal, which is recorded by a data logging system. A method requiring only aqueous standards is used to calibrate the system for both aqueous and organic uranium solutions. Detailed statistical analysis of the experimental data is included. A deviation noted from Beer's law is explained by inclusion of scattering effects into the describing model. Solution analyses made using this model result in values accurate to better than ±0.5 g/l over the range of uranium concentrations from 0 to 120 g/l. (auth)

22145 A NEW PRINCIPLE OF ACTIVATION-ANALYSIS SEPARATIONS. IX. SUBSTOICHIOMETRIC DETERMINATION OF TRACES OF BISMUTH. Jaromir Ruzicka, Adolf Zeman, and Ivan Obrusnik (Faculty of Technical and Nuclear Chemistry, Prague). Talanta, 12: 401-7(Apr. 1965).

A radiochemical separation of bismuth was developed, based on two dithizone extraction steps, the second of which is a substoichiometric extraction. When copper, gold, mercury, palladium, platinum, and silver are not present in interfering amounts, only the substoichiometric dithizone extraction is necessary. The method was applied to the determination of bismuth by activation analysis in granite and in silicon. (auth)

22146 LUMINESCENCE OF THE RARE EARTH ELEMENTS AND ITS APPLICATION IN ANALYTICAL CHEMISTRY. L. I. Anikina and A. V. Karyakin (Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Usp. Khim., 33: 1337-48(1964).

An extensive review was made of literature on the luminescence of rare earths. Basically, the light absorption and luminescence of the rare earth elements are related to the 4f shell, which is shielded by the outer shells and produces discrete spectra. The luminescence of pure salts and solutions is discussed. The absorption spectra in the infrared, visible, and ultraviolet regions show narrow bands. In the far ultraviolet they become continuous. Discrete spectra of the rare earth ions are due to quasi-forbidden transitions. Unlike other elements, the rare metal salts are also luminescent in solution, maintaining the solid-state spectrum. Luminescent analysis can be used for quantitative determinations. The luminescence of crystallophosphors activated by rare earth elements is discussed. Rare earths are used as minute additives to oxides, sulfides, fluorides, sulfates, silicates, phosphates, tungstates, and molybdates. Their ionic radius should be commensurate with that of the activator. Here too, luminescence is proportional to content and can be used for the quantitative determination of the rare earths. With respect to the luminescence of organic internal complexes of the rare earth elements, the photoluminescent spectra of these compounds are basically no different from those of the simple salts of these elements. The energy distributuon depends on the nature of the organic ligand. Sometimes ions show fluorescence only under certain conditions, mostly at low temperatures (except Eu). A sensitive method permitting the determination of 10^{-4}% Eu and 10^{-3}% Tb is described. (CFSTI)

22147 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN ORES AND FUEL MATERIALS AS $Na_4[UO_2(CO_3)_3]$ OR $K_4[UO_2(CO_3)_3]$. Alex. Thiemann, Siegfried Kiessling, and Franz Jansen (Kernforschungsanlage, Julich, Ger.). Z. Anal. Chem., 208: 332-3(1965). (In German)

Determination of uranium in ores or fuels as the sodium or potassium uranyl carbonate by spectrophotometric methods is described. Amounts of the uranyl complex between 10 and 1000 mg in 100 ml of solution can be determined with an accuracy of 1%. (M.C.G.)

22148 A γ-γ COINCIDENCE ARRANGEMENT FOR ACTIVATION-ANALYSIS DETERMINATION OF TRACE AMOUNTS OF SELENIUM AND IRIDIUM IN MINERALS, NICKEL, IRON, AND PLATINUM METALS. W. Herr and R. Woelfle (Universitat, Cologne and Kernforschungsanlage, Julich, Ger.). Z. Anal. Chem., 209: 213-26(Feb. 24, 1965). (In German)

On the basis of their complex and characteristic decay schemes, a number of radionuclides formed by neutron capture can be selectively detected and quantitatively determined by means of γ-γ coincidence measurements. The method was specifically applied to the elements selenium (^{75}Se) and iridium (^{192}Ir). It was the advantage of extremely high sensitivity of detection (about 10^{-10} gram) and permits the performance of nondestructive analyses in suitable matrix materials, such as iron and platinum. Disturbances due to the presence of other γ-emitters can largely be prevented by discrete choice and adjustment of the coincidence ranges. The influence of the sample composition and dimensions is discussed. The particular advantage of the method consists in a considerable simplification and reduction of the time of chemical treatment. (auth)

22149 REPORT ON OXYGEN DETERMINATION IN URANIUM CARBIDE. H. Nickel, J. Rottmann, H. J. Stoecker, and A. Koester-Pflugmacher (Kernforschungsanlage, Julich, Ger. and Technische Hochschule, Aachen). Z. Anal. Chem., 209: 226-43(Feb. 24, 1965). (In German)

Comparable experiments on the determination of oxygen impurities in uranium carbides by vacuum-fusion and inert-gas-fusion methods were performed, using various temperatures and bath compositions (iron, cobalt, and nickel). The latter fusion method proved to be unsatisfactory. Best results were obtained by the vacuum-fusion method, using a cobalt bath at 1900 to 2000°C. Thermodynamic evaluations were in good agreement with the experimental results. Metallographic and autoradiographic investigations explained that the unfavorable behavior of powdered samples compared to massive samples were chiefly due to the increasing graphite precipitation in the bath. (auth)

22150 DETERMINATION OF HYDROGEN IN REFRACTORY METAL HYDRIDES. M. M. Antonova (Inst. of Material Problems, Kiev). Zh. Anal. Khim., 19: 1408-10 (1964).

A study was made on the conditions for combustion of titanium, zirconium, niobium, and vanadium hydrides in an oxygen current to determine hydrogen in these hydrides. Combustion was carried out in a quartz tubular reactor, which is described. Hydrogen was determined as H_2O from the increase in weight of the absorption tubes. The optimum combustion temperatures were 900°C for titanium hydride, 800°C for zirconium hydride, 1000°C for vanadium hydride, and 1100°C for niobium hydride. The time required for the analysis is not more than 30 min. The relative experimental error for the hydrogen determination is about 1.5%. The analytical procedure is described. (CFSTI)

22151 METODY KOLICHESTVENNOGO OPREDELENIYA ELEMENTOV. (Methods for Quantitative Determination of Elements). V. I. Tikhomirov, ed. Leningrad, Publishing House of the Leningrad University, 1964. 146p.

Twenty-three papers are included on the determination and separation of rare metals, rare earths, and uranium by means of optical analysis, amperometric and luminescence titration, ion exchange, and solvent extraction. Certain theoretical problems in trilonometric titration are also discussed. (R.V.J.)

22152 ANALYSIS AND MEASUREMENT OF MATERIALS WITH LOW ENERGY RADIATION. Charles O. Badgett. 22p. (CONF-641017-7)

From Symposium on Low Energy X and Gamma Sources and Applications, Chicago.

It is shown that soft x-ray or gamma photons may be used for measurement of properties of materials. Both physical and chemical properties may be expressed in terms of energy and/or absorption values. Examples of the use of such ideas in simple stream analysis are presented for illustration. Use of low-energy photons permit reasonably small amounts of shielding and the manufacture of high-strength (intense) radiation sources having selected wavelengths of emission. This selective radiation can in turn be used to measure several different material properties. (auth)

22153 ELECTROLYTIC METHOD FOR THE CONTINUOUS MEASUREMENT OF OXYGEN IN LIQUID SODIUM. M. Kolodney, B. Minushkin, and H. Steinmetz (United Nuclear Corp., White Plains, N. Y.). 8p. (CONF-641018-4)

From The Electrochemical Society 126th Meeting, Washington, D. C.

A solid electrolyte galvanic cell was developed for use in continuous monitoring of the oxygen content of liquid sodium. The solid electrolyte may be ZrO_2-CaO, ZrO_2-Y_2O_3, or ThO_2-Y_2O_3. Cu-Cu_2O reference electrodes were found to be the most stable and reproducible, and ThO_2-Y_2O_3 electrolyte gave the best results. Cells operated satisfactorily for periods of over four months. Long-term response to

changes from about 35 to 70 ppm oxygen was observed. (M.C.G.)

22154 PRELIMINARY RESULTS OF X-RAY FLUORESCENT ANALYSIS IN THE ENERGY RANGE FROM 1 TO 5 kev. Troy C. Martin, Kenneth R. Blake, and Ira L. Morgan (Texas Nuclear Corp., Austin). 33p. (CONF-641017-2).

From Symposium on Low Energy X and Gamma Sources and Applications, Chicago.

A gas proportional counter was constructed with a thin Be window, which is able to detect the K x rays of elements down to and including the F K-α x ray (0.677 kev). Preliminary data were obtained for Mg (1.254 kev) and Si (1.74 kev) in an Fe_2O_3 matrix. Errors due to matrix or interelement effects are shown. The source used was a Ti-^{3}H preparation. Fluorescent excitation of Ti, NaCl, Si, Al, and Mg were compared in an air and helium atmosphere. The effect of air absorption was clearly demonstrated. Fluorescent spectra of nickel, of fluorine in teflon, and of calcium and silicon in ocean core samples are given. Data are presented in tables and graphs. (M.C.G.)

22155 THE ANALYSIS OF TRACE IMPURITIES IN HELIUM. 23p. (CONF-721-13).

From 8th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1964.

Determination of trace impurities in helium coolant for the Dragon reactor is discussed. A flow diagram of the gas sampling system is presented. Adsorption errors in gas sampling are described. Two sensing devices, the high-frequency and high-temperature Lambert gas discharge detector and the Lovelock ionization detector, were tested with a view to low level helium process analysis. Adaptation of an electrolytic water analyzer to Dragon coolant analysis is discussed. The methods of gas analysis investigated cover the range down to almost 0.01 vpm at standard temperature and 19 atm. (M.C.G.)

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Refer also to abstracts 22264, 22863, 22935, 23164, 23255, and 23355.

22156 (AEET/CD/34) STUDIES ON THE PREPARATION OF HIGH-PURITY ANTIMONY. R. Krishna Iyer and T. R. Bhat (Atomic Energy Establishment, Trombay (India). Chemistry Div.). 1964. 14p. Dep.(mn).

A method for the preparation of high purity antimony starting from commercial metal is given. The method consists of conversion of the metal to the trichloride by chlorination, distillation of the chloride with hydrochloride acid and subsequent rectification, conversion of the chloride to the oxide, reduction of the oxide to the metal with hydrogen followed by vacuum rectification of the metal. Each step was studied in detail and the optimum conditions were established. The metal prepared was found to be suitable for semi-conductor applications. (auth)

22157 (BNL-8062) POSITION AND THERMAL PARAMETERS OF OXYGEN ATOMS IN CALCITE. Henry Chessin, Walter C. Hamilton, and Ben Post (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The position and thermal parameters of oxygen atoms in calcium carbonate (calcite) at room temperature, 215 and 130°K, were determined. Reflections to which only oxygen atoms contribute were measured using counter methods. Parameters were refined by least squares methods. The C–O bond length is 1.2825 Å ± 0.0015 at room temperature and does not change significantly between room temperature and 130°K. (auth)

22158 (BNL-8385) A KINETIC STUDY OF THE DECOMPOSITION OF CESIUM–GRAPHITE LAMELLAR COMPOUNDS. F. J. Salzano and S. Aronson (Brookhaven National Lab., Upton. N. Y.). [1964]. Contract AT(30-2)-Gen-16. 32p. (CONF-571-36). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

A kinetic study of the decomposition of the cesium-graphite lamellar compounds in vacuo was carried out over the temperature range 400 to 650°C. A tracer technique was used in which the concentration of cesium in the compounds was measured by a scintillation scanning probe which continuously monitored the activity of tracer ^{134}Cs. The decomposition of the cesium-graphite compounds proceeds in distinct stages. Within each stage, a constant rate of decomposition is observed. Each stage corresponds to the transition of one cesium-graphite compound to a compound containing less cesium. The observed rates of decomposition can be explained by assuming the rate limiting process to be the evaporation of cesium from the external surface of the solid. The proposed mechanism correlates the kinetic data with the thermodynamic properties of the compounds. (auth)

22159 (FSU-2690-18) DELOCALIZED EXCITATION AND EXCITATION TRANSFER. Bulletin No. 18. Th. Foerster (Florida State Univ., Tallahassee. Dept. of Chemistry). [1964]. Contract AT(40-1)-2690. 68p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Delocalized excitation and excitation transfer are discussed in terms of stationary and of nonstationary wave functions. The result is obtained that the apparently different cases of strong, weak, and of very weak coupling are intimately related to each other and might, in principle, be described by one single theory. Their different characteristics result merely from a difference in magnitude of the interaction energy, in relation to the electronic band width and to the individual vibronic band width. The conditions for very weak coupling seem to be met much more often than has been recognized in the recent literature. Actually, for this case to be present, the interaction energy has not even to be small on an absolute scale, as has been found in the discussion of molecules with continuous spectra. Excitation transfer between triplet states, that is $T_1 \rightarrow S_0$ in one molecule together with $T_1 \leftarrow S_0$ in the other, is spin forbidden, and the interaction energy is small even for molecules in close contact with each other. A value of 8 cm^{-1} has been found by Nieman and Robinson for this energy in case of the benzene crystal. At liquid helium temperature this may be sufficient for weak coupling but no more at essentially higher temperatures where the vibronic band widths exceed that amount considerably. Then, stepwise transfer of excitation instead of exciton propagation should be expected, and the individual transfer rates should be treated by very weak coupling theory, in Dexter's modification for forbidden transitions. Even if the conditions for strong or for weak coupling apply, so that electronic or vibronic excitons do exist, their migration is still modified by the thermal redistribution of energy between different vibronic levels. In exciton theory this is considered by the inclusion of exciton-phonon-scattering. This allows linear migration of excitons in a lattice over restricted distances only, but leads then to diffensive motion. Model calculations under such conditions have been performed by Goad. As Katshura has shown, frozen lattice irregularities lead to a similar behavior. In both cases, the root-mean-square displacement of the excitation becomes finally proportional to $\sqrt{t}$, as in diffusion or in a random walk process. With the same individual transfer rate this may result in much smaller rates for trapping by impurities, especially in one-dimensional systems where a random walk includes repeated visits of the same place. (auth)

22160 (IA-964) SOME REMARKS ON THE ASSIGNMENTS OF THE FURNACE ABSORPTION SPECTRA OF Ce, Nd, AND Sm. Sima Held (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Establishment). Jan. 1965. 42p. Dep.(mn).

The furnace absorption spectra of Ce, Nd^{14}, and Sm were investigated in order to determine whether all the lines

belong to the neutral atom spectrum. The spectrum assignments were made using only a d-c arc as the excitation source. It was observed that in the ultraviolet and red spectral ranges not all the absorption lines previously reported belong to the neutral atom spectrum. The spectrum assignments of the stronger Nd lines in the long wavelength region are given. The method of sorting the atom and ion spectra of rare earth elements used may be helpful in the long wavelength region. (auth)

22161 (IS-T-5) A STUDY OF TUNGSTEN(II) AND TUNGSTEN(III) BROMIDES (thesis). Gary Austin Murray (Ames Lab., Iowa State Univ. of Science and Tech.). Feb. 1965. Contract W-7405-eng-82. 50p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Tungsten(II) bromide was prepared by aluminum reduction of tungsten(V) bromide in a temperature gradient of 550/300°C. The reaction was performed in a sealed, evacuated Vycor tube. Final heat treatments of the product yielded tungsten(II) bromide in good yields and purity. The bromide, formed a hydrate upon exposure to air and eventually underwent hydrolysis. An x-ray diffraction powder pattern of tungsten(II) bromide hydrate was compared to an x-ray diffraction powder pattern of molybdenum(II) bromide hydrate, the structure of which is known. The two hydrates were found to be isostructural, and the existence of the polynuclear tungsten halide ion, $(W_6Br_8)^{4+}$, was confirmed. Tungsten(II) bromide is soluble in absolute ethanol and from this solution a diethanolate was obtained, which was formulated by analytical and molecular weight determinations as $(W_6Br_8)Br_4(C_2H_5OH)_2$. This also supports the existence of the polynuclear tungsten halide ion. Spectral work on tungsten(III) bromide in absolute ethanol showed that reduction of tungsten(III) bromide to tungsten(II) bromide occurs in short periods of time. The solution chemistry of the former compound was greatly hampered by this fact. A study of the kinetics of the formation of tungsten (III) bromide by the reaction of liquid bromine and tungsten (II) bromide indicated that the reaction is zeroth order. The rate of reaction appears to be dependent upon factors such as particle size, surface area, surface conditions, etc. (auth)

22162 (ORNL-3776(p.17-22)) INVESTIGATION OF THE CHEMICAL BEHAVIOR OF RADIOIODINE VAPORS. (Oak Ridge National Lab., Tenn.).

Studies were performed to determine the extent of reaction at 24°C between iodine and organic vapors. One source of organic vapors was a mixture of lubricating oil, plastic, and rubber insulating material. A second source was dioctyl phthalate (DOP), a compound commonly used for in-place testing of filters. The results show that as much as 10% of the elemental iodine was converted to different forms. The presence of moisture to the extent of 30% relative humidity interfered with the adsorption of the volatile fraction of iodine (mainly methyl iodide) by charcoal-lined diffusion tubes. Normal adsorption deposition patterns were obtained under dry conditions. The presence of an unknown material as well as traces of methyl iodide and hydrogen iodide were detected in a preliminary test where iodine vapor was contacted with oxidized mild steel at 100°C in the presence of a reducing steam atmosphere. Effective sorption of fission products by surfaces of reactor structural materials can be of considerable significance in determining the severity of reactor accidents. Experimental observation of the vapor-metal-surface interaction in an otherwise inert atmosphere showed that carbon steel sorbs about an order of magnitude more iodine than stainless steel does in a given time, and that the surface area of stainless steel increases as the surface is oxidized. Sorption of iodine by stainless steel is slower the more highly oxidized the surface, and it seems to be limited to a few monolayers. Cesium vapor is sorbed by stainless steel to an extent of greater than ten monolayers, and sorption appears to be enhanced on the more highly oxidized surface. A study was also made of the deposition of iodine from flowing gas streams on heated mild steel and stainless steel surfaces. Tubes of these metals were placed in furnaces with temperature gradients, and the distribution of iodine in the tubes was determined as a function of wall temperature in various carrier gases including helium-steam, hydrogen-steam, and air-steam mixtures. Mild steel tubes retained 95 to 98% of the gas-borne iodine when air was absent, as compared with 70 to 95% for stainless steel tubes. In the presence of air, the retention on mild steel was 75%, while stainless steel retained only 15%. The temperature at the peak of the distribution curve ranged from 150 to 400°C for stainless steel and from 400 to 550°C for mild steel. (auth)

22163 (ORNL-3776(p.43-6)) REMOVAL OF IODINE AND VOLATILE IODINE COMPOUNDS FROM AIR SYSTEMS BY ACTIVATED CHARCOAL. W. E. Browning, Jr., R. E. Adams, and F. V. Hensley, Jr. (Oak Ridge National Lab., Tenn.).

The behavior of methyl iodide and iodine vapor toward four types of activated charcoal under varying degrees of temperature and humidity was investigated. The charcoals were selected to represent four types of this material: bituminous coke, petroleum residue, coconut shell, and a metal-impregnated bituminous coke. Under dry conditions (relative humidity <3%) and at room temperature, all the charcoal types are effective against methyl iodide and iodine vapor. Under wet conditions (relative humdity approximately 75%) and at room temperature, all the charcoal types were effective against elemental iodine but relatively ineffective against methyl iodide. The efficiency for methyl iodide retention ranged from 50 to 97%, with coconut charcoal producing the higher efficiency. Under low humidity and high temperature (100 to 150°C), all charcoal types had high efficiencies for retention of both elemental iodine and methyl iodide. Under steam conditions, at temperatures ranging from 95 to 130°C, the efficiency of the charcoals for methyl iodide is quite low, ranging from 5 to 78%. The efficiency for elementary iodine is also reduced slightly under these conditions, averaging probably about 98%. These studies are continuing. (auth)

22164 (ORNL-TM-1054) DIRECT OBSERVATION OF PARTICLE REENTRAINMENT FROM SURFACES. Liliana Masironi and B. R. Fish (Oak Ridge National Lab., Tenn.). Feb. 10, 1965. Contract W-7405-eng-26. 13p. (CONF-555-18). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964.

Particle reentrainment from various surfaces is observed and photographed microscopically in a small wind tunnel. In this apparatus, the dynamics of a moving particle in an airstream are studied by multiple flash photomicrography. Soda-lime glass beads 28.9 μ mean diameter (±13%) on a glass surface in a turbulent flow field (Re = 24,400) exhibit three main modes of response at low relative humidity: first, about half of the glass spheres do not move under repeated application of the air flow; approximately one-third of the beads leave the surface directly; finally, the remainder move slowly and intermittently along the surface until the majority of these are entrained in the airstream over a relatively longer period of time. (auth)

22165 (JPRS-28849(p.1-10)) STATE AND PROBLEMS OF INVESTIGATIONS OF ALLOYS OF THE RARE EARTH METALS. E. M. Savitskii. Translated from p.7-14 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The progress in studies of rare earth metals and their alloys since the Nov. 1957 conference is surveyed. The work done in other countries as well as in USSR is considered. It is pointed out that the application of rare earths is hindered by the lack of knowledge of their properties. The proposed physicochemical mechanisms of the action of rare earths on other metals and alloys are outlined. Some of the practical problems (purity, organizations, costs, etc.) of studies of rare earths are mentioned. Industrial applications are considered, and the most important tasks in rare earth science are summarized. (D.L.C.)

22166 (JPRS-28849(p.272-8)) DEOXIDATION OF STEEL WITH LANTHANUM, CERIUM, PRASEODYMIUM, AND NEODYMIUM. G. Kinne, A. F. Vishkarev, Yu. V. Kryakovskii, and V. I. Yavoiskii. Translated from p.204-

8 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

Thermodynamic calculations were made on the deoxidation reactions of La, Ce, Pr, and Nd at 1600°. An experimental study of the deoxidation of liquid iron in a steam–H_2 atmosphere in refractory oxide crucibles showed that the rare earths reduce the crucible material. The rare earth oxides thus formed were identified as La_2O_3, Nd_2O_3, and Pr_2O_3; CeO_2 or Ce_2O_3 is formed, depending on the conditions of the meltings. The deoxidizing ability of the rare earths was determined indirectly using Al_2O_3 crucibles, and the temperature dependences of the equilibrium constants of the deoxidation reactions were derived. Oxygen equilibrium concentrations were calculated for La at 1600°. (D.L.C.)

22167 (UCRL-Trans-1099(L)) ENTHALPIES OF FORMATION OF IONS OH^-, K^+, Na^+, Li^+ IN AQUEOUS SOLUTIONS. A. F. Vorob'ev, A. S. Monaenkova, N. M. Privalova, and S. M. Skuratov. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore), from Vestn. Mosk. Univ., Ser. II: Khim, 18: No. 3, 48-51(1963). 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI; $1.10(fs), $0.80(mf) JCL.

Data are presented on the enthalpies of formation of OH^-, K^+, Na^+, and Li^+ ions. The methods for calculating the enthalpies are described. All the values of the enthalpies of formation for the ions are expressed in calories and pertain to a standard temperature of 25°C. (P.C.H.)

22168 THE CRYSTAL STRUCTURE OF URANIUM CHLORIDE π-TRICYCLOPENTADIENYL. Chi-hsiang Wong, Tung-mou Yen, and Tseng-yuh Lee (National Tsing Hua Univ., Taiwan). Acta Cryst., 18: 340-5(Mar. 10, 1965).

The crystal structure of uranium chloride π-tricyclopentadienyl was determined by analysis of x-ray diffraction data. The crystals are monoclinic, space group $P2_1/n$, with $a = 8.26$, $b = 12.50$, and $c = 13.81$ Å and $\beta = 90.6°$. There are four molecules per unit cell. The coordinates for the uranium atom were determined from two Patterson projections. The structure was then deduced from a three-dimensional Fourier synthesis and, later, a difference synthesis. The positional and vibrational parameters for the uranium and chlorine atoms were refined by least-squares calculations, and the positional parameters for the carbon atoms were refined by another difference synthesis. The bond lengths are: U–Cl = 2.559 ± 0.016 and U–C = 2.74 Å. A regular planar pentagonal structure for the cyclopentadienyl rings with C–C ≃ 1.4 Å is compatible with the difference maps. These results indicate that the U–Cl bond is essentially ionic, and that there are approximately three pairs of electrons responsible for the bonding between the uranium atom and the three cyclopentadienyl groups. The cyclopentadienyl rings and the chlorine atom form a distorted tetrahedron about the uranium atoms. (auth)

22169 THE CRYSTAL STRUCTURE OF SODIUM TRIDECAFLUORODIZIRCONATE. R. M. Herak, S. S. Malcic, and Lj. M. Manojlovic (Inst. of Nuclear Science "Boris Kidrich", Belgrade). Acta Cryst., 18: 520-2(Mar. 10, 1965).

The crystal structure of sodium tridecafluorodizirconate, $Na_4Zr_2F_{13}$, was determined from two-dimensional x-ray data. The crystal lattice is built of endless slabs of $[Zr_2F_{13}]^{5-}$ ions, running parallel to the b axis; the ions of sodium are arranged at the interstitial sites of this lattice. The coordination polyhedron around each zirconium atom is a trigonal prism, with an additional tetragonal pyramid. Two such ZrF_7 polyhedra, connected by a common fluorine atom placed at the apex of the tetragonal pyramid, form the $[Zr_2F_{13}]^{5-}$ complex ion. (auth)

22170 THE SPACE GROUP OF $LaAlO_3$ BELOW 720°K, AND THE COMPOUNDS $NdAlO_3$ AND $PrAlO_3$, PROBABLY ISOMORPHOUS AT ROOM TEMPERATURE. B. Derighetti, J. E. Drumheller, F. Laves, K. A. Mueller, and F. Waldner (Universitat, Zurich; Eidgenossische Technische Hochschule, Zurich; and International Business Machines Corp., Zurich). Acta Cryst., 18: 557(Mar. 10, 1965).

It is shown that only two space groups, R3c and $R\bar{3}c$, would conform with x-ray data and resonance data for $LaAlO_3$, and $R\bar{3}c$ is proposed as the most probable. It was concluded that since the compounds $NdAlO_3$ and $PrAlO_3$ are reported to be isomorphous with $LaAlO_3$ they too probably have the same space group. (M.C.G.)

22171 NEUTRON DIFFRACTION STUDY OF AMMONIUM OXALATE MONOHYDRATE, $(NH_4)_2C_2O_4 \cdot H_2O$. V. M. Padmanabhan, S. Srikantha, and S. Medhi Ali (Atomic Energy Establishment, Trombay, India). Acta Cryst., 18: 567-8(Mar. 10, 1965).

Neutron diffraction intensities for 125 (hkO) and 45 (Okl) reflections were measured to an estimated average accuracy of 4% for ammonium oxalate monohydrate. The space group and unit cell were found to be P2,2,2, z = 2, a = 8.04, b = 10.27, and c = 3.82 Å. Extinction was judged to be unimportant. A projection of the neutron scattering density is shown. Interatomic distances and bond angles are given. (M.C.G.)

22172 PHOSPHATES AND POLYPHOSPHATES OF THE LANTHANIDE ELEMENTS. VII. SAMARIUM, GADOLINIUM AND DYSPROSIUM TRIPHOSPHATES. Ernesto Giesbrecht and Ebe Barbieri Melardi (Universidade de Sao Paulo, Brazil). Anais Acad. Brasil. Cienc., 36: 275-81(1964).

The potentiometric and conductometric titrations of samarium, gadolinium and dysprosium chloride solutions with sodium triphosphate solutions or vice-versa showed the formation of compounds in which the ratio Ln^{3+}: $P_3O_{10}^{5-}$ is respectively 5 : 3 (insoluble), 1 : 1 (insoluble) and 1 : 2 (soluble). The compounds $Ln_5(P_3O_{10})_2$, H_2O, were isolated and analyzed. The change of the absorption spectrum of Gd^{3+} ions in the ultraviolet region when complexed with $P_3O_{10}^{5-}$ ions is presented and the influence of the ratio Gd^{3+}: $P_3O_{10}^{5-}$ and pH values are discussed. (auth)

22173 CHRONOPOTENTIOMETRIC EVIDENCE FOR THE FORMATION OF EUROPIUM(III) ACETATE COMPLEXES. Daniel J. Macero, Harvey B. Herman, and Alexander J. Dukat (Syracuse Univ., N. Y.). Anal. Chem., 37: 675-7(May 1965).

The reduction of Eu(III) to Eu(II) was studied by voltammetry at constant current in sodium acetate and acetic acid solutions at constant ionic strength. The pH was kept constant at 4.5. Concentration vs. the square root of transition time plots at a current density of 0.0282 ma/cm² were linear in accordance with the Sand equation. A diffusion coefficient of 0.40×10^{-5} cm²/sec was evaluated for Eu(III) in 0.1M acetate solution at 25°C. The product, $i_\tau^{\frac{1}{2}}/C$, was constant over a range of current densities and europium (III) concentrations. The electrode reaction for the reduction of Eu(III) to Eu(II) in the acetate system was found to be reversible from current reversal studies and potential vs. time plots. Evidence is given for the presence of the acetate complexes, $Eu(OAc)^{2+}$ and $Eu(OAc)_2^+$. The values of the corresponding stability constants were calculated to be 324 and 20.4. (auth)

22174 THE H-D EXCHANGE BETWEEN TOLUENE AND DEUTERIUM GAS IN THE PRESENCE OF RANEY NICKEL. Leopold Horner, Dietmar Mayer, Brigitte Michael, and Hermann Hoenders (Universität, Mainz). Ann. Chem., 679: 1-9(1964). (In German)

The exchange of deuterium for hydrogen in toluene was studied at normal pressure and ambient temperature in the absence of water. Preliminary experiments indicated that maximum D content of toluene is attained more rapidly than in the case of benzene; hydrogenation and exchange occur independently of each other; an isotope effect in favor of organically bound D was observed, for after 14 hr 18.1% D was found in the substrate, but still only 10% D in the gas phase. Deuterated methylcyclohexane contained from 2.07 to 2.28 D atoms per molecule. The distribution of D in toluene was calculated by the method of Bonner (J. Am. Chem. Soc., 79: 2469 (1957)) and is given below as % of maximum exchangeable hydrogen for three separate determinations: total, 18.2, 17.7, 18.2; nucleus, 13.5, 11.8, 12.1; methyl, 26.2, 27.6,

28.3; o-, 4.0, 1.2, 1.2; m-, 21.3, 18.0, 18.5; p-, 16.8, 20.6, 21.2. Thus about one fifth of all H atoms are replaced by D; all of the H atoms in toluene are replaceable; nearly a third of the H atoms in the side chain are replaced, as opposed to a tenth in the nucleus. The m- and p- positions differed very little in exchange ratios, while that of the o-position was much smaller. (BBB)

22175 NEW COORDINATION COMPOUNDS OF THE LANTHANIDES. Vittorio Carassiti, Alberto Seminara, and Amelia Seminara-Musumeci (Universitã, Ferrara, Italy). Ann. Chim. (Rome), 54: 1025-37(Nov. 1964). (In Italian)

Several new coordination compounds of Tm and Lu were prepared by mixture of alcoholic solutions of their anhydrous chlorides with alcohol-ether solutions of 2,2'-dipyridyl and 1,10-phenanthroline. White precipitates were formed, washed with an ether-alcohol mixture, and dried over P_2O_5 at low pressure. Analysis indicated the formation of $Tm(dipy)_2Cl_3$, $Lu(dipy)_2Cl_3$, $Tm(phen)_2Cl_3$, and $Lu(phen)_2Cl_3$, the dipyridyl complexes as monohydrates and Lu phenanthroline complex as a dihydrate. Thermogravimetric data are presented in support of these findings. Tables of the infrared spectra of the two ligands and the four new compounds covering the range 650 to 2500 cm^{-1} are given for mineral oil suspensions of the solids. For all the compounds there are indications of a cis configuration of the ligands, although the suggestions are stronger for some compounds than others. Ultraviolet spectra in solution and conductivities were also measured; these indicate very small stability constants. Thus the compounds are nearly completely dissociated in solution, as is generally found for coordination compounds of the lanthanides. (BBB)

22176 CONTRIBUTION TO THE STUDY OF THE ROTATION SPECTRA OF ISOTOPIC SO_2 MOLECULES. R. Van Riet (Centre de Physique Nucleaire et Moleculaire, Heverle-Louvain, Belg.). Ann. Soc. Sci. Bruxelles, Ser. I, 78: 237-67(Dec. 23, 1964). (In French)

The pure rotation spectra of the molecules $^{34}S^{16}O^{18}O$ (0,1,0) and $^{34}S^{18}O^{18}O$ (0,1,0), in the first excited state of the ν_2 vibration, were obtained and calculated. The effective rotation constants and the distortion coefficients were determined in the first-order approximation. As a result of an extension of the experimental range, the already known spectra of the isotopic SO_2 molecules were completed. In particular, new values of the rotation constants and the distortion coefficients were proposed for $^{32}S^{16}O^{16}O$ (0,1,0), $^{32}S^{16}O^{16}O$ (0,0,0), $^{33}S^{16}O^{16}O$ (0,1,0), $^{34}S^{16}O^{18}O$ (0,0,0), and $^{34}S^{16}O^{16}O$ (0,1,0). These new values took into consideration the attributions of Morino and of Bauer et al. (tr-auth)

22177 ON THE VOLATILITY OF IODINE FROM EVAPORATING AQUEOUS IODIDE SOLUTIONS OF LOW CONCENTRATION. H. W. Levi and E. Schiewer (Hahn-Meitner-Institut fur Kernforschung, Berlin). Atomkernenergie, 10: 45-6(Jan.-Feb. 1965). (In German)

The influence of oxidizing agents and of H^+ concentration on the volatility of iodine from aqueous iodide solution was investigated. Increasing H^+ concentration has no influence up to p_H5. In more acid solutions, iodine may be fixed by adding $KMnO_4$, provided the solution is virtually free of Cl ions. (auth)

22178 THE INFLUENCE OF BOND MAKING AND BOND BREAKING IN THE TRANSITION STATE OF HYDROGEN ISOTOPE EFFECTS IN LINEAR THREE-CENTER REACTIONS. A. V. Willi and M. Wolfsberg (Brookhaven National Lab., Upton, N. Y.). Chem. Ind. (London), No. 51, 2097-8 (Dec. 19, 1964). (BNL-8402)

As represented by the following equation, three-center reactions where hydrogen B is transferred from donor A to acceptor C (both represented here by single atoms) occur frequently, and some hydrogen isotope effects (k_H/k_D), were measured: $AB + C \rightarrow [A\,..\,B\,..\,C]^{\ddagger} \rightarrow A + BC$. Theoretical treatments were carried out within the transition state theory framework, usually assuming a linear ABC transition state. With neglect of bending motions, the potential energy expression of the transition state is given in terms of F_{11}, F_{22} (stretching force constants) and F_{12} (an interaction force constant). In a series of different transition states, F_{22} is taken to increase, with bond making, to the product value while at the same time F_{11} decreases, with bond breaking, from the reactant value. The frequency of crossing the barrier has in the past usually been set zero, corresponding to $F_{11}F_{22} - F_{12}^2 = 0$. With neglect of bending motions and of tunnelling, k_H/k_D then reaches a maximum when $F_{11} \sim F_{22}$. The isotope effect is small if $F_{11} \ll F_{22}$ or $F_{22} \ll F_{11}$. In slow organic reactions, high potential barriers are passed whose curvature may be non-negligible; transition state force fields leading to imaginary frequencies $\nu_L^{\ddagger}$ corresponding to such curvature were explored. Calculations were carried out in the harmonic approximation with the IBM-7094 digital computer. Conclusions from the two types of calculations performed were similar. Maximum k_H/k_D is fairly independent of the curvature parameter in the absence of tunnelling. This maximum is largely a function of the reactant molecule force constant. Attempts were made to assess the influence of tunneling, but the simple approaches tried had little theoretical significance. (TCO)

22179 THE COORDINATION CHEMISTRY OF YTTRIUM AND THE RARE EARTH METAL IONS. Therald Moeller, Dean F. Martin, Larry C. Thompson, Ricardo Ferrus, Gerald R. Feistel, and William J. Randall (Univ. of Illinois, Urbana). Chem. Rev., 65: 1-50(Feb. 1965).

A review is presented on the characteristics of known complex species, both in the solid state and in solution, the factors that are involved in the formation of these species, and the nature of the ligand-cation bond. The topics are discussed in terms of uses to which the complex species are put. It is shown that the related coordination chemistry of Sc and the actinide metal ions is readily understandable in terms of differences from and similarities to the coordination chemistry of the rare earth metal ions. Of the complex species derived from Y and the rare earth metal ions described, some exist only in solution, some exist only in the solid state and dissociate or decompose upon dissolution, and still others have sufficient stability with respect to their components that they exist both in solution and in the solid state and thus appear capable of participating in reactions without undergoing change in composition. Most species that have been characterized are derived from tripositive metal ions. The values of the formation constants for the rare earth complexes that have been investigated since 1955 for organic ligands and 1956 for inorganic ligands are also tabulated. A discussion of the trends in the formation-constant data for rare earth metal complexes is included. The unsatisfactory state of interpretation of the trends in the rare earth formation-constant data led to examination of the thermodynamics of the formation of some of these species in aqueous solution. Bonding in complex species, with chemical and physical data and their interpretation, is also considered. It was concluded that bonding in the coordination compounds of Y and rare earth metal ions may be considered as involving, fundamentally, electrostatic interaction. Even in the most stable complexes, the bond strength has the same order of magnitude as the free ion-water dipole interaction. Thus, it is predicted that stability would be improved by working in systems where the solvation energy is lower, e.g., in water-dioxane mixtures. Use of fractional crystallization and precipitation, solvent extraction, and ion exchange to separate rare earth metal ions is also considered. 651 references are included. (TCO)

22180 THE ORTHOVANADATE OF THORIUM. Giles Le Flem, Antoine Hardy, and Paul Hagenmuller (Service de Chimie Minerale de la Faculte des Sciences, Bordeaux). Compt. Rend., 260: 1663-5(Feb. 8, 1965). (In French)

The structure, a lacune zircon type, of thorium orthovanadate $Th_3(VO_4)_4$ was shown by the existence of solid solutions without miscibility gaps with cerium orthovanadate $CeVO_4$ with the general formula $Th_{3x}Ce_{(1-x)}(VO_4)_4$. This result was confirmed by obtaining mixed vanadates of thorium and sodium $Th_{(3-x)/3}Na_{4x/3}(VO_4)_4$, isomorphic with

$Th_3(VO_4)_4$. The parameters of $Th_3(VO_4)_4$ were defined as a = 7.26 and c = 6.474 Å. (tr-auth)

22181 INVESTIGATIONS IN THE SYSTEM $N_2H_6F_2$–UF_6–HF. B. Frlec, B. S. Brcic, and J. Slivnik (Nuclear Institute "Jozef Stefan," Ljubljana, Yugoslavia). Croat. Chem. Acta, 36: 173(1964). (In German)

The synthesis of ternary uranium fluoride in water-free hydrogen fluoride is described. The reaction product is a yellow, loose powder, which corresponds to the formula $N_2H_5UF_7$. Percentages determined were 8.6% N_2H_4, 59.6% U, and 32.3% F. (auth)

22182 ULTRA-VIOLET EMISSION SPECTRA OF XENON AND KRYPTON FLUORIDES. S. L. N. G. Krishnamachari, N. A. Narasimham, and Mahavir Singh (Atomic Energy Establishment, Trombay, India). Current Sci. (India), 34: 75-7(Feb. 5, 1965).

During investigations on the emission spectra obtained in discharges through BF_3 in the presence of xenon and krypton, spectral features were observed in the region 2200 to 3500Å, which were attributable to fluorides of xenon and krypton. Characteristics of the spectra are described. (M.C.G.)

22183 INTERMOLECULAR PROTON TRANSFER IN SOLUTIONS. E. A. Pshenichnov and N. D. Sokolov (Inst. of Physics and Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 174-7(Nov. 1, 1964). (In Russian)

Proton transfer from one molecule to another occurs if a hydrogen bond is formed between them. This bond, AH...B, plays the role of a donor-acceptor interaction between the molecule of the base B and the proton, representing the first stage of the proton transfer from A to B. The proton transition AH...B → A + (HB) practically never occurs in the gaseous phase and in nonpolar solutions because of the endothermic character of the process. In a complex compound with an H bond, the width Δ of the vibrational levels of the protons is usually much smaller than the distance ω between them; therefore, calculation of the rate of the multistage proton transfer from one potential sink to another involves 2 independent problems: the separate determination of the transfer probability between each pairs of 2 levels and the solution of the kinetic equations for the whole system. Formulas were derived for the case involving an arbitrary number of levels in the second sink, assuming that a downward relaxation occurs sufficiently fast and excluding the possibility of transition under the barrier. Similar calculations were carried out for the transition probability between two levels under the influence of random forces acting from the solvent side of the AH...B complex, determining the conditions of energy exchange between molecules. The kinetics of the previously discussed bromination of 2-carboxy cyclopentanone and acetone in aqueous solutions was used as an example of proton transfer. (TTT)

22184 PYROLYTIC STABILITY OF DIPHENYLBENZENEBORONATE. G. F. Nencetti, G. Nardini, and S. Zanelli (Universita, Pisa, Italy). Energia Nucl. (Milan), 12: 100-1(Feb. 1965). (In Italian)

The pyrolytic stability of diphenylbenzeneboronate was determined at temperatures up to 450°C. The volume of total gas, the volume of gas not condensed at −75°C, and the volume of gas not condensed at −190°C produced from the pyrolysis of pure diphenylbenzeneboronate was determined as a function of the pyrolysis temperature. Only at temperatures above 400°C did the formation of small quantities of gas, the first indication of pyrolytic alterations, become evident. (J.S.R.)

22185 X-RAY SPECTRAL INVESTIGATION OF SAMARIUM HEXABORIDE. E. E. Vaynshteyn, S. M. Blokhin, and Yu. B. Paderno. Fiz. Tverd. Tela, 6: 2909-12(1964).

The samarium hexaboride was obtained by a vacuum-thermal method. For comparison and to facilitate the interpretation of the data, x-ray L_{III} absorption spectra were obtained for europium and ytterbium oxides and hexaborides, using the same experimental conditions. The absorption spectra were obtained with a long-wave x-ray spectrograph in the first order of reflection from the (1340) plane of a quartz crystal. The spectra were recorded photographically. The $L_{\alpha 2}$ and $L_{\alpha 3}$ lines of europium were used as the comparison lines. The structure of the L_{III} absorption edges of samarium in SmB_6 was investigated in the interval from −120 to +400°C. An analysis of the fine structure indicated that the samarium atoms exist in SmB_6 in two different valence states, which are statistically distributed in crystallographically equivalent positions of the lattice of the compound. The absorption spectrum of samarium in SmB_6 has several features distinguishing it from hexaborides of other rare earths. The most important of these features is the presence of an additional absorption band whose maximum is shifted by about 7 ev towards the longer wavelengths compared with the principal maximum. This hypothesis was confirmed by plotting the theoretical absorption curves corresponding to the different relative contents of the divalent and trivalent samarium and a corresponding analysis. It was estimated that the divalent samarium may amount to ~(35 ± 5)% of the total number of samarium atoms. (CFSTI)

22186 INNER 4f-TRANSITIONS OF NEODYMIUM TRICYCLOPENTADIENIDE AT LIQUID HELIUM TEMPERATURES. R. Pappalardo (Cyanamid European Research Inst., Cologny, Switzerland). Helv. Phys. Acta, 38: 178-88(1965).

Optical absorption data are reported for Nd^{3+} tricyclopentadienide in 2-methyltetrahydrofuran at low temperatures. Transitions are found from levels at ~70, ~310, ~570, and ~670 cm^{-1} over the ground state. Some of the observed lines at low temperatures show a pronounced low-energy shift with respect to known Nd^{3+} systems. Two hypersensitive lines are found at 16828 and 16986 cm^{-1}. (auth)

22187 EXPERIMENTAL STUDY OF THE ENTHALPY OF HEAVY WATER IN THE SUPERCRITICAL RANGE OF PARAMETERS OF STATE. A. E. Sheindlin and N. I. Gorbunova (Scientific Research Inst. of High Temperatures, USSR). High Temp. (USSR) (English Transl.), 2: 437-9 (May-June 1964). Translated from Teplofiz. Vysokikh Temp., 2: 484-7(May-June 1964).

The enthalpy of heavy water was experimentally determined at pressures of 250 to 500 kg/cm^2 and temperatures of 350 to 460°C. The results were compared with values obtained from data on the heat capacity and from the equation of state. (D.C.W.)

22188 PHASE TRANSFORMATION IN ERBIUM ETHYL SULPHATE SINGLE CRYSTAL WITH LOWERING OF TEMPERATURE. T. Mookherji (Univ of Burdwan, W. B., India). Indian J. Phys., 38: 587-8(Nov. 1964).

Measurements on the magnetic anisotropy and mean magnetic moment of a single crystal of $Er_2(C_2H_5SO_4)_6\ 18H_2O$ were carried out by modifications of Stout and Griffel's method and a Curie balance, respectively. A change of ~75° was observed in the direction of the principle magnetic axis for decreasing temperature. The results support the view that the symmetry of the crystal was changing from hexagonal to either monoclinic or triclinic with the change of temperature. (L.B.S.)

22189 THERMAL STUDIES ON HYDRATES OF ZIRCONYL, THORIUM AND URANYL PERCHLORATES. P. Rama Murthy and C. C. Patel (Indian Inst. of Science, Bangalore). Indian J. Pure Appl. Phys., 3: 134-5(Mar. 1965).

The thermal behavior of crystalline zirconyl perchlorate $ZrO(ClO_4)_2 \cdot 8H_2O$, thorium perchlorate $Th(ClO_4)_2 \cdot 4H_2O$, and uranyl perchlorate $UO_2(ClO_4)_2 \cdot 6H_2O$ was studied using DTA (differential thermal analysis) and TGA (thermogravimetric analysis) techniques. Various transitions in the thermograms are characterized. It was found that the final exothermic decomposition of the perchlorates to the

corresponding metal oxide occurs through the formation of the anhydrous compounds $ZrO(ClO_4)_2$, $ThO(ClO_4)_2$, and $UO_2(ClO_4)_2$, respectively. (auth)

22190 THE ROLE OF THE MONOFLUOROIRON(III) IN THE IRON(II)–IRON(III)–FLUORIDE ION ISOTOPE EXCHANGE REACTION. Jameel Menashi, Shouzow Fukushima, Charles Foxx, and Warren L. Reynolds (Univ. of Minnesota, Minneapolis). Inorg. Chem., 3: 1242-5 (Sept. 1964). (TID-20277)

The iron(II) + iron(III) exchange rate was measured in $NaF-NaClO_4-HClO_4$ media at constant pH and ionic strength. The iron(II) concentration was increased so as to make the isotope exchange rate comparable to the rate of formation of the inner coordination shell complex FeF^{2+}. The observed isotope exchange rate was dependent on the rate of formation of FeF^{2+} in the manner expected if the activated complex $[Fe_2F^{4+}]^*$ was formed from $Fe^{2+}(aq)$ and $FeF^{2+}(aq)$. (auth)

22191 REACTIONS OF HAFNIUM HYDROXIDE WITH YTTRIUM, LANTHANUM, NEODYMIUM AND YTTERBIUM HYDROXIDES. L. N. Komissarova, Ken-shih Wang, and Vikt. I. Spitsyn (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Khim., No. 1, 3-11(1965). (In Russian)

The reactions of hafnium hydroxides with the hydroxides of Y, La, Nd, and Yb were investigated in the temperature interval from 100 to 1000°C using thermographic and x-ray methods of analysis. In suitable coprecipitation conditions the hydroxides reacted at temperatures below 600°C with the formation of chemical compounds, pyrohafnates of La and Nd or solid solutions in the case of oxides of Y or Yb. In mechanical mixtures of hydroxides the reactions proceeded at high temperatures (>1000°C). The reaction capacity of oxides of the rare earth elements in the reaction with HfO_2 decreased in the series La_2O_3, Nd_2O_3, Y_2O_3, and Yb_2O_3. The temperatures at the beginning of crystallization and the dimensions of the crystal lattice parameters forming new phases decreased with a decrease in the size of the rare earth ion. (tr-auth)

22192 ON A SERIES OF SOLVENTS ACCORDING TO THE INCREASING FORCE OF OSCILLATION ABSORPTION BANDS OF PRASEODYMIUM, NEODYMIUM, SAMARIUM, AND ERBIUM. R. I. Slavkina and V. V. Serebrennikov (Tomsk State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 1, 181-3(1965). (In Russian)

The position of water and nine organic solvents (acetone, methyl ethyl ketone, propyl and butyl alcohol, ethylene glycol, glycerol, pyridine, acetic acid, and acetic anhydride) according to the increasing force of oscillation absorption bands of Pr, Nd, Sm, and Er ions was determined using the previously developed formula: $f = (3mC/\pi e^2)\varphi(n)\int k\nu d\nu$. The position in the series of the solvent was found to depend on the position of the absorption band in the spectrum, anion salt, and the presence of water of crystallization. (R.V.J.)

22193 OXIDATION BEHAVIOR OF URANIUM MONOPHOSPHIDE. Y. Baskin (Argonne National Lab., Ill.). J. Am. Ceram. Soc., 48: 153-6(Mar. 21, 1965).

Oxidation of UP at moderate temperatures was studied using DTA (differential thermal analysis), x-ray diffraction, TGA (thermogravimetric analysis), and chemical analysis. Heating rates, atmosphere, and particle size were varied. Oxidation behavior of UP was significantly different from that of UC, UN, US, and UAs, all of which possess the NaCl-type crystal structure. The greater oxidation resistance of UP was attributed to surface formation of an amorphous phase containing P_2O_5 and UO_2. Existence of this coating was thought to be responsible for the nontarnishing and generally nonpyrophoric nature of UP at room temperature. (auth)

22194 KINETICS OF THE NEPTUNIUM(V)–CHROMIUM(VI) REACTION IN PERCHLORATE SOLUTIONS. James C. Sullivan (Argonne National Lab., Ill.). J. Am. Chem. Soc., 87: 1485-8(Apr. 5, 1965).

The empirical form of the rate law determined for the oxidation of Np(V) by Cr(VI) in a perchloric acid–lithium perchlorate media is $d[NpO_2^+]/dt = k[NpO_2^+]\cdot[CrVI]/(1 + k'[NpO_2^{+2}]/[NpO_2^+])$ at constant hydrogen ion concentration. The hydrogen ion temperature dependences of k and k′ are presented. (auth)

22195 STRUCTURE AND BONDING IN A TEN-COORDINATE LANTHANUM(III) CHELATE OF ETHYLENEDIAMINETETRAACETIC ACID. M. D. Lind, Byungkook Lee, and J. L. Hoard (Cornell Univ., Ithaca, N. Y.). J. Am. Chem. Soc., 87: 1611-12(Apr. 5, 1965).

Reactions of lanthanum carbonate with EDTA gave a solution from which monoclinic crystals were obtained by slow evaporation at room temperature. Studies by x-ray diffraction lead to the structural formulation $La(OH_2)_4(C_2H_3O_2)H\cdot 3H_2O$ and assigned the asymmetric ten-coordinate configuration to the molecule. The crystals, space group $P2_1/a$, have a = 11.85 ± 0.01, b = 18.08 ± 0.02, and c = 8.80 ± 0.01 Å, β = 91.75 ± 0.10°. (M.C.G.)

22196 ON THE STRUCTURE-DEPENDENT BEHAVIOR OF ETHYLENEDIAMINETETRAACETATO COMPLEXES OF THE RARE EARTH Ln^{3+} IONS. J. L. Hoard, Byungkook Lee, and M. D. Lind (Cornell Univ., Ithaca, N. Y.). J. Chem. Soc., 87: 1612-13(Apr. 5, 1965).

Rare earth ions (Ln^{3+}) were complexed by ethylenediaminetetraacetate ions in aqueous solutions. The asymmetric nine-coordinate $Ln(OH_2)_3(C_2H_3O_2)^{++}$ ion is shown to exist in the potassium salt. It was found that potassium salts with Ln = La, Nd, or Gd, sodium salts with Ln = Nd, Tb, or Er, and ammonium salts with Ln = Nd or Gd all crystallize in the space group Fdd 2 with 16-molecule units of comparable and similarly ordered dimensions. This apparent isomorphism is charged to the presence of asymmetric chelated anions, which are so bulky and retentive of the shape-determining chelation pattern as to fix the basic character of the crystalline framework. (M.C.G.)

22197 APPLICATION OF HIGH-TEMPERATURE MASS SPECTROMETRY TO THE DETERMINATION OF THE ENTHALPY-COMPOSITION FUNCTION OF NONSTOICHIOMETRIC BINARY COMPOUNDS. Karl A. Gingerich (Pennsylvania State Univ., University Park). J. Am. Chem. Soc., 87: 1660-4(Apr. 20, 1965).

The application of high temperature, Knudsen-cell mass spectrometry to the determination of the enthalpy-composition function is shown for nonstoichiometric compounds that have a range of composition and vaporize by decomposition into a volatile component and a solid solution of the same phase. In principle, the temperature dependence of the partial pressure of the volatile component is measured for a constant composition of the solid and a partial enthalpy value derived. The enthalpy-composition function for the whole homogeneity range is obtained accordingly by measurements for different compositions. The approach is demonstrated for praseodymium monophosphide. The partial molal enthalpy of P_2 decomposition, $\overline{\Delta H}_T[P_2]$, for the reaction $(2/x)PrP_y(s) = (2/x)PrP_{y-x}(s) + P_2(g)$ was found to increase with decreasing P/Pr atomic ratio from 79.5 to 120.5 kcal over the composition range measured. The suitability and limitations of the proposed method are discussed. (auth)

22198 REACTIONS OF THE URANIUM CARBIDES WITH NITRIC ACID. Leslie M. Ferris and Mildred J. Bradley (Oak Ridge National Lab., Tenn.). J. Am. Chem. Soc., 87: 1710-14(Apr. 20, 1965). (ORNL-P-842)

Uranium carbides reacted with 2 to 16M HNO_3 at 25 to 120°C yielding uranyl nitrate, soluble organic acids, NO_2, NO, and CO_2. No hydrogen, CO, or gaseous hydrocarbons were produced. Between 50 and 80% of the carbide carbon was converted to CO_2. The soluble organic species consisted of oxalic acid (0 to 11% of the carbide carbon), mellitic acid (2 to 9% of the carbide carbon), and unidentified compounds, which were probably aromatics highly substituted with –COOH and –OH groups. The carbides were practically passive in boiling 0.001 to 0.5M HNO_3. (auth)

22199 OXIDATION OF PLUTONIUM(III) BY XENON TRIOXIDE. J. M. Cleveland (Dow Chemical Co., Golden, Colo.). J. Am. Chem. Soc., 87: 1816(Apr. 20, 1965).

The reaction $6Pu^{3+} + XeO_3 + 6H^+ \rightarrow 6Pu^{4+} + Xe + 3H_2O$ was found to proceed at a measurable rate. The oxidation reaction was studied at 30.0 ± 0.2°C in perchlorate solutions. Data indicated that the reaction is second order, and described by the rate expression $-d[Pu^{3+}]/dt = k[Pu^{3+}][XeO_3]$, with k having an average value of 1.6×10^{-2} l/mole sec at 30°C. (M.C.G.)

22200 THE OXIDATION OF URANIUM DIOXIDES. D. E. Y. Walker (United Kingdom Atomic Energy Authority, Springfields, Lancs, Eng.). J. Appl. Chem. (London), 15: 128-35(Mar. 1965).

The oxidation of three types of uranium dioxide (UO_2) material was investigated in the 120 to 360°C range. In UO_2 powders, with surface areas greater than about 2 m^2/g, oxidation was diffusion-controlled up to U_3O_7 which oxidized to U_3O_8 above about 240°C. The activation energies were in the range from 20 to 27 kcal/mole. For material with very low surface areas, both electrolytic UO_2 powder (0.0405 m^2/g) and sintered pellets (5 cm^2/g) were oxidized by nucleation and growth-controlled processes. The growth activation energies for the two materials were 32.19 and 26.38 kcal/mole, respectively. Considerable differences occurred in the oxidation rate of pellets from batch to batch. Material with intermediate surface-areas comprising sintered powder (0.135 m^2/g) and crushed sintered pellets (0.095 m^2/g) gave oxidation curves, which were a hybrid between the other two types. At a high enough temperature (~420°C), the 0.095-m^2/g material showed a completely sigmoid nucleation type of curve. Some x-ray diffraction studies were performed at intermediary stages in the oxidations to trace the presence of the γ-UO_2 phase, and the differences in behavior are discussed and explanations given. (auth)

22201 CHEMISORPTION ON SINGLE-CRYSTAL PLANES: NITROGEN ON TUNGSTEN. T. A. Delchar and Gert Ehrlich (General Electric Research Lab., Schenectady, N. Y.). J. Chem. Phys., 42: 2686-2702 (Apr. 15, 1965).

The effects of surface structure on the adsorption of nitrogen were examined by contact-potential measurements on macroscopic planes cut from single-crystal tungsten. On the (100) plane, room-temperature chemisorption lowered the work function by 0.4 ev, confirming previous field-emission results. Flash desorption revealed only one state, β, in which nitrogen was bound as adatoms. On the considerably less reactive (111) plane, the work function ϕ rose by 0.15 ev. Two states contributed: α, which is probably molecular, and β; both raised ϕ. At higher concentrations, a second β state was isolated by flash desorption. Nitrogen did not chemisorb at all on the (110) at 300°K and $p \sim 10^{-7}$ mm. Adsorption of γ nitrogen could, however, be observed by lowering the temperature to T ~ 130°K or raising the pressure above 10^{-3} mm. On the (110) plane, this state was atomic and lowered ϕ. On other planes, γ-nitrogen had different properties and formed because of the heterogeneity induced in the surface layer by the presence of adatoms. Macroscopic surfaces could therefore be prepared showing extreme structural specificity. Previous correlations between the work-function changes and electronegativities were examined and found insufficient. The effects of structure on the surface dipole were, however, correlated by the empirical rule that nitrogen atoms on flat planes lower the work function, whereas on rough surfaces the work function is increased. (auth)

22202 FORMATION OF H_3^+ AND H_5^+ IONS. M. Saporoschenko (Washington Univ., St. Louis). J. Chem. Phys., 42: 2760-4(Apr. 15, 1965).

H^+, H_2^+, H_3^+, and H_5^+ ions were identified in hydrogen gas by use of a mass spectrometer with the ion source in the pressure range from 10^{-3} to 0.5 mm Hg. Secondary ions were formed in steps of consecutive reactions between ions and hydrogen molecules. Reaction cross sections of the secondary H_3^+ ions were determined from the concentration dependence of the intensities of the H_5^+ ions. The tertiary H_5^+ ion was formed in three-body collisions of the H_3^+ ion with hydrogen molecules. Dissociation processes of all three molecular ions were observed. (auth)

22203 DEUTERIUM AND TRITIUM SATURATED-LIQUID PVT ACCORDING TO THE QUANTUM-MECHANICAL PRINCIPLE OF CORRESPONDING STATES. John D. Rogers and F. G. Brickwedde (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 42: 2822-5(Apr. 15, 1965). (LA-DC-6798)

The quantum-mechanical principle of corresponding states was used to determine the saturated-liquid PVT of D_2 and T_2 up to the critical points. The critical-point temperature of T_2 was determined to be 40.0°K and the critical-point density to be 0.109 g/cm^3. (auth)

22204 PHOTOSENSITIZED IONIZATION OF ALKALI-METAL VAPORS. Yuan-tseh Lee and Bruce H. Mahan (Univ. of California, Berkeley). J. Chem. Phys., 42: 2893-6(Apr. 15, 1965). (UCRL-11842)

The vapors of potassium, rubidium, and cesium were photoionized with light absorbed in the discrete region of the atomic spectrum. The energy threshold for the ionization process was determined and the ions produced identified by mobility measurements. The data give lower limits for the dissociation energies of K_2^+, Rb_2^+, and Cs_2^+. Each of these molecular ions has a bond energy approximately 50% greater than that of the corresponding neutral molecule. In addition, lower limits for the electron affinities of the alkali atoms and approximate values for the mobilities of Rb^+ and Rb_2^+ in rubidium vapor are given. (auth)

22205 OPTICAL PROPERTIES OF TETRAVALENT NEPTUNIUM IN LEAD MOLYBDATE. William Phillips and J. M. Feldman (Carnegie Inst. of Tech., Pittsburgh). J. Chem. Phys., 42: 2933-41(Apr. 15, 1965).

The optical properties of neptunium in single-crystal lead molybdate were measured to determine the suitability of Np^{4+} ions for laser applications. It was found that neptunium enters the crystals predominantly in the tetravalent state, with Np^{4+} ions occupying Pb^{2+} lattice sites. Another ionization state, probably Np^{6+}, also appeared, but was eliminated by the presence of Na^+ in the crystals. Optical absorption at wavelengths longer than 0.6 μ was due to transitions from the $^4I_{\frac{9}{2}}$ ground state to the other members of the ^4I multiplet. Fluorescence, arising from $^4I_{\frac{11}{2}} \rightarrow {}^4I_{\frac{9}{2}}$ transitions, was excited by pumping in the 0.6-to-1.3-μ region. The emission filled a band between 1.6 and 2.2 μ at room temperature, but at 77°K it was confined largely to five lines, the narrowest of which had a width of about 13 cm^{-1}. The quantum efficiency at 77°K approached unity. Laser threshold calculations for $PbMoO_4$ containing 0.005 mole % Np^{4+} indicated a rather high pulsed threshold at 77°K. However, crystals containing 0.1 mole % at Np^{4+} would have thresholds low enough for cw operation. Concentrations of this magnitude are not realizable in $PbMoO_4$, but this is not necessarily the case for the other scheelite-structured tungstates and molybdates. (auth)

22206 SELECTIVE ENHANCEMENT OF FLUORESCENCE FROM SOME RARE-EARTH SALTS IN SOLUTION. Raymond P. Borkowski, Harvey Forest, and Daniel Grafstein (General Precision Aerospace Research Center, Little Falls, N. J.). J. Chem. Phys., 42: 2974-5(Apr. 15, 1965).

The fluorescence at equal concentration (0.25M) of solutions of $EuCl_3 \cdot 6H_2O$ in H_2O and D_2O were examined in order to determine the effects of deuteration on the intensity and lifetime of the emission bands. The fluorescence intensity, as measured by the area under the emission band, was about 11 times greater in D_2O than in H_2O for the two $^5D_0$ transitions, while the 555-mμ band showed far less enhancement. The enhancement factor for the $^5D_0$ transition was about 7 times that of the $^5D_1$ transition. In D_20 each Th^{3+} band was enhanced by a factor of about 6.5, and each Sm^{3+} band by a factor of 14. (M.C.G.)

22207 INFLUENCE OF THE RADII OF NEIGHBORING IONS ON THE OPTICAL ABSORPTION OF THALLIUM IN

ALKALI HALIDES. Amal K. Ghosh (Argonne National Lab., Ill.). J. Chem. Phys., 42: 2978-9(Apr. 15, 1965).

In thallium-doped alkali halides, there are three bands known as the A, B, and C bands. An empirical relation was found to exist between the positions of the A and C bands and the radii of the alkali metal and halide ions. If the position of the A band is plotted as a function of the radius of the alkali metal ion, the absorption for the chlorides, bromides, and iodides are found to lie on lines parallel to one another. The iodides have the lowest energies and the chlorides the highest. The C band behaves as the A band. (M.C.G.)

22208 CALCULATED IONIZATION POTENTIAL OF CHLORO- AND FLUOROMETHANES, TETRAFLUOROMETHANE (CF_4), XENON TETRAFLUORIDE (XeF_4), AND XENON TETRACHLORIDE ($XeCl_4$). Charles E. Melton and Hubert W. Joy (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 42: 2982-3(Apr. 15, 1965). (ORNL-P-913)

An energy-calibrated molecular orbital method in the LCAO approximation was used to calculate the ionization potentials for methane, chloro- and fluoromethanes, xenon tetrafluoride, and xenon tetrachloride. (M.C.G.)

22209 INTERMEDIATE COUPLING ENERGY LEVELS FOR $Nd^{3+}(4f^3)$ IN LaF_3. H. H. Caspers, H. E. Rast, and R. A. Buchanan (Naval Ordnance Lab., Corona, Calif.). J. Chem. Phys., 42: 3214-17(May 1, 1965).

The absorption spectrum of $Nd^{3+}(4f^3)$ was investigated in the spectral region from 4100 to 60 000 Å. Fluorescence at 77 and 4.2°K was observed corresponding to transition from the excited $^4F_{\frac{3}{2}}$ levels to all the Stark components of the $^4I_{\frac{9}{2}}$ and $^4I_{\frac{11}{2}}$ levels. By means of a least-squares method, the Slater and spin-orbit parameters were calculated from experimentally observed levels whose LSJ assignments were reliable. The values of these parameters giving a best fit between the predicted free-ion spectrum and the spectrum of Nd^{3+} in LaF_3 were $F_2 = 338.439$, $F_4 = 47.153$, $F_6 = 5.579$, and $\zeta = 882.109\ cm^{-1}$. The average deviation of eight of these levels was $10\ cm^{-1}$. (auth)

22210 ELECTROCHEMICAL REDUCTION OF URANIUM(VI) AT MERCURY ELECTRODES IN CARBONATE SOLUTIONS. AN EXPERIMENTAL CHRONOPOTENTIOMETRIC STUDY. J. Caja and V. Pravdic (Institut "Ruder Boskovic," Zagreb). J. Electroanal. Chem., 8: 390-8 (Nov. 1964).

The chronopotentiometric technique was used in studying the reduction of uranyl ions on mercury electrodes in sodium carbonate solutions. At 1M of free carbonate no kinetic complications were observed at experimental conditions pertinent to galvanostatic techniques for quiescent solutions. At low free carbonate concentrations (0.10M) the electrochemical reduction was followed by a second-order chemical reaction the rate of which was dependent on the concentration of the free carbonate ion. The potential-time relation was a suitable means of studying the kinetics as dependent on the free ligand concentration and on the concentration of the electroactive uranyl ion. The data indicated that the uranyl tricarbonate complex undergoes reduction without dissociation, while the coupled chemical reaction (disproportionation) involves rearrangement in the transition of uranium(V) into the uranium(IV) and uranium (VI) carbonate complex forms. (auth)

22211 SOME X-RAY AND THERMOELECTRIC STUDIES ON CUBIC Th_3X_4 COMPOUNDS. C. E. Price and I. H. Warren (Univ. of British Columbia, Vancouver). J. Electrochem. Soc., 112: 510-13(May 1965).

Measurements of thermoelectric power and electric conductivity were made up to 950°C on Th_3P_4, Th_3As_4, Th_3Sb_4, and $Th_3(AsSb)_4$ solid solutions. Thermal conductivity data were obtained near 30°C. X-ray and density measurements suggested that the compounds are stoichiometric. (auth)

22212 A KINETIC STUDY OF THE ISOTOPIC EXCHANGE OF THALLIUM(III) BETWEEN THE THALLIUM ION(III) AND THALLIUM ETHYLENEDIAMINE-N,N,N',N'-TETRA-ACETATE IN WATER. M. Tsuchimoto and K. Saito (Tokyo Univ.). J. Inorg. Nucl. Chem., 27: 849-58(Apr. 1965).

Isotopic exchange of thallium (III) ion and its EDTA complex is immeasurably slow in neutral solutions and very fast in basic and acid solutions. The rate is measurable in the pH region near 3 and 10, in the presence of chloride and triethanolamine, respectively. The rate constant is independent of the concentration of uncomplexed thallium and proportional to that of the complex in both regions. Near pH 10, the rate constant is proportional to the concentration of OH^- ions and to that of triethanolamine, and the Arrhenius activation energy is 22 kcal per mole. In the acid region near pH 3, the rate constant is apparently proportional to the concentration of $[H^+]^{1.4}$ and to that of $[Cl^-]^{1.5}$ and the Arrhenius activation energy is 8.5 kcal per mole. It appears that the mechanism of exchange is different in these two pH regions. (auth)

22213 THE REACTION OF LITHIUM FLUORIDE WITH THE TRIFLUORIDES OF LANTHANIDES AND SOME ACTINIDES. C. Keller and H. Schmutz (Technische Hochschule, Karlsruhe, Ger. and Institut für Radiochemie Gesellschaft für Kernforschung mbH, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 27: 900-1(Apr. 1965). (In German)

Studies on the reactions of lithium fluoride with rare earth and actinide fluorides showed that the trifluorides of Ce, Pr, Np, Pu, and Am did not react to form a product while trifluorides of the heavy rare earths reacted with LiF in HF at 400–650°C from 2 to 5 hr to form Li rare earth fluorides with the formula $LiMeF_4$. Lattice constants of the $LiMeF_4$ compounds where Me = Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, and Y are tabulated. (P.C.H.)

22214 THE REACTION OF LOWER HALIDES WITH CYCLOPENTADIENE: MONO- AND DICYCLOPENTADIENYL HALIDES OF ZIRCONIUM AND TITANIUM. A. F. Reid and P. C. Wailes (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Organometal. Chem. (Amsterdam), 2: 329-35(Oct. 1964).

The compounds $C_5H_5ZrCl_3$, $C_5H_5ZrBr_3$, and $C_5H_5ZrI_3$ and the reported compound $C_5H_5TiCl_3$ were prepared by the reaction of cyclopentadiene vapor with the metal trihalides. The compounds $(C_5H_5)_2ZrCl_2$ and $(C_5H_5)_2ZrBr_2$ were prepared similarly from the dihalides. Solution methods were also used to prepare $C_5H_5ZrCl_3$, $C_5H_5ZrBr_3$, and $(C_5H_5)_2ZrI_2$, previously uncharacterized, and an improved characterization of $C_5H_5TiCl_3$ was made. All of these compounds contained π-bonded cyclopentadienyl structures. (auth)

22215 SUBSTITUENT EFFECTS ON INTRAMOLECULAR ENERGY TRANSFER. I. ABSORPTION AND PHOSPHORESCENCE SPECTRA OF RARE EARTH β-DIKETONE CHELATES. W. F. Sager, N. Filipescu, and F. A. Serafin (George Washington Univ., Washington, D. C.). J. Phys. Chem., 69: 1092-1100(Apr. 1965).

The absorption and phosphorescence spectra of differently substituted rare earth β-diketonates were investigated. The influence of the substituents on the electronic states of the organic ligand is discussed in relation to the over-all intramolecular energy migration. (auth)

22216 THE DECOMPOSITION PRESSURE AND MELTING POINT OF THORIUM MONONITRIDE. W. M. Olson and R. N. R. Mulford (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem., 69: 1223-6(Apr. 1965). (LA-DC-6662)

Measurements of the decomposition pressure for the reaction $ThN(s) = Th(l) + \frac{1}{2}N_2(g)$ in the temperature range from 2416 to 2790°C are described. ThN melted congruently at 2790 ± 30°C under a nitrogen pressure of somewhat less than 1 atm. The presence of ThO_2 as an impurity in the ThN was found to have a large effect on the melting point and decomposition pressure. The decomposition pressure-temperature relation for pure ThN is described by the equation $\log p\ (atm) = 8.086 - 33{,}224/T + 0.958 \times 10^{-17}T^3$(T in °K.). Insofar as could be determined from x-ray lattice parameter data, ThN exists over little or no stoichiometry range. (auth)

22217 THE IMPORTANCE OF XENON FLUORIDES IN THE XENON-PHOTOSENSITIZED REACTIONS OF THE PERFLUOROALKANES. Glenn H. Miller (Univ. of California, Santa Barbara) and J. R. Dacey. J. Phys. Chem., 69: 1434-5(Apr. 1965).

The role of xenon fluorides in the xenon-photosensitized reactions of perfluoroalkanes is discussed. The reactions of $c\text{-}C_4F_8$ are used as an example. It was concluded that the main initial step is $Xe^* + c\text{-}C_4F_8 \rightarrow XeF_2 + c\text{-}C_4F_6$. (M.C.G.)

22218 INTERPRETATION OF OPTICAL SPECTRA OF d^1 SYSTEMS. Y. J. Israeli (Hebrew Univ., Jerusalem). J. Phys. Chem. Solids, 26: 441-3(Feb. 1965). (In French)

The optical spectra of Ti(IV), Sc(III), Y(III), and La(III) were studied in the form of impurities in CaF_2 crystals. Previous experimental results are interpreted, considering tetragonal distortion of the spectrum as the primary factor, and spin-orbit coupling as a secondary perturbation. Electric dipole transitions are considered in D_{4h} symmetry for the d^1 systems. (M.J.T.)

22219 INVESTIGATION OF THE RATE AND MECHANISM OF REACTIONS BY MEANS OF HIGH-RESOLVING NUCLEAR MAGNETIC RESONANCE SPECTRA. Ivamura Khide. Karaku No Ryoiki, 17: No. 4, 8(1963). (In Japanese)

The quantitative relation between reaction rate and nuclear magnetic resonance (NMR) spectrum was determined from the Bloch equation. Using the NMR method, the rate constant (51×10^{10} sec^{-1}) for the proton exchange reaction in ammonia and water, which corresponds to the diffusion mechanism of Brownian motion, was previously found by Emerson. In a series of measurements Bergu found the exchange rate constant for protons and an amide and an activation energy of 13 to 15 kcal/mole. It was established that the exchange rate of protons in water depends on the pH, and the exchange rate constant is not dependent on the pH. The exchange rate constant of protons in the OH of ethyl alcohol was 0.08 l/mole sec. Apbba and others determined the exchange rate constant of protons in hydrogen peroxide for a pH between 2.5 and 6.5 at 27 ± 2°C. The exchange rate of protons in acetylene derivatives depended on the electronegativity of the R group in the RC ≡ C molecule. In general, the exchange rate constant increased with increasing electronegativity of the R group. By the NMR method it was shown that exchange of protons is accomplished between the SH of thioalcohols and the OH of phenols. It was observed that the NMR method makes possible the determination of an instantaneous exchange rate in the limits 1 to 10^{-3} sec^{-1}. (IIC-M.G.)

22220 RELAXATION BY SLOW MOTIONAL PROCESSES. EFFECT OF MOLECULAR ROTATIONS IN PURE QUADRUPOLE RESONANCE. S. Alexander and A. Tzalmona (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 138: A845-55(May 3, 1965).

Slow motional processes for which there is no motional narrowing can be important in spin-lattice relaxation. These relaxation mechanisms cannot be treated by perturbation theory. It is shown that the relaxation times are directly proportional to the motional correlation times. It is suggested that they can be used very effectively to measure the rate of motional processes in solids. A theory of the direct effect of molecular rotations on longitudinal spin relaxation in pure quadrupole resonance is described. The theory is applied to the ^{14}N resonance in hexamethylene tetramine. Measurement of the longitudinal relaxation times in this molecule were carried out by a steady-state pulse method, and the rotational correlation times were determined. The results are in agreement with previous nmr measurements. (auth)

22221 X-RAY DETERMINATION OF THE COEFFICIENT OF THERMAL EXPANSION OF ScB_2. N. N. Zhuravlev and A. A. Stepanova (Moscow State Univ.). Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 6, 83-4(Nov.-Dec. 1964). (In Russian)

The ScB_2 compound has an AlB_2 type hexagonal lattice with the parameters a = 3.14 and c = 3.51 Å. The x-ray diffraction analysis of ScB_2 powder at 20 to 600°C showed that a and c lattice parameters increased almost linearly with increasing temperature. The calculated mean coefficients of thermal expansion were $6.8 \times 10^{-6} \pm 0.5 \times 10^{-6}$ and $7.6 \times 10^{-6} \pm 0.5 \times 10^{-6}$ $degree^{-1}$ along the a and c axes, respectively. (CFSTI)

22222 INFRARED SPECTRA OF URANYL NITRATE HEXAHYDRATE AND ITS AQUEOUS SOLUTIONS. V. M. Vdovenko, D. N. Suglobov, and A. P. Taranov. Radiokhimiya, 6: 559-68(1964). (In Russian)

The infrared spectra of $UO_2(NO_3)_2 \cdot 6H_2O$ and $UO_2(NO_3)_2 \cdot 6D_2O$ were measured from 400 to 4000 cm^{-1}. Each, from the frequencies of the volume oscillations of the uranyl and nitrate groups, split into two components. In the proposed structural modification of the hexahydrate, either all or half of the nitrate groups, were coordinated to the uranium. The partition of the oscillation deformation frequency of water into two components specified the existence, in the hexahydrate lattice of the uranyl nitrate, of two groups of molecules of water participating in both very powerful and very weak hydrogen bonds. The number of bonds in regions of OH valence oscillations responded to smaller dimensions for three types of water molecules. The bonds of antisymmetrical valence oscillations in spectra of diluted aqueous solutions of the nitrates were split, which indicated deformation of symmetric arrangements of the NO_3^- ions in the vicinity of the water molecule. The size of the splittings increased insignificantly with increasing salt concentration. In the spectra of concentrated uranyl nitrate solutions (more than 2M) bonds appeared at 1500 cm^{-1} indicating coordinated nitrate groups. In aqueous solutions with the water activity below 0.5 [fusion $UO_2(NO_3)_2 \cdot 6H_2O$ at 60°, solutions $UO_2(ClO_4)_2 + UO_2(NO_3)_2$] the nitrate groups occurred principally in coordinate states. (tr-auth)

22223 THE STATE AND COMPLEXING OF SCANDIUM IN MINERAL ACID SOLUTIONS. A. P. Samodelov. Radiokhimiya, 6: 568-81(1964). (In Russian)

The complexing constants of scandium in solutions of nitrate salts was determined by the ion exchange and extraction method. The dependence of the distribution of the ionic and electron electroneutral forms of scandium in nitrate salt solutions on the concentration was determined from data on the partition of scandium by ion exchange, electron migration, and extraction. Complexing constants of scandium with chlorine ions were calculated. The results obtained were compared with the results of a series of other works and were in agreement with well-known mechanisms. (tr-auth)

22224 MASS SPECTROMETRIC MEASUREMENT OF NITROGEN ISOTOPE CONTENT RATIO. Ryohei Nakane (Inst. of Physical and Chemical Research, Tokyo). Shitsuryo Bunseki, No. 22, 51-6(June 1963). (In Japanese)

The preparation of specimens for mass spectrometric measurements of ^{15}N content is discussed. This includes the equations employed in N_2 gas mass spectrometric calculations, background noise caused by contamination of foreign elements, memory effects due to residual specimen gas, specimen preparations from $(NH_4)_2SO_4$, Kjeldahl conversion processes, relations between the specimen's N content and the measured ^{15}N content, alteration of ^{15}N concentration during the conversion process, and dilution effects. It is pointed out that the observance of two principles is essential for an accurate result, viz, the conversion to N_2 gas of the specimen must be total and complete; and a care must be taken to prevent dilution of ^{15}N in specimen when its concentration is higher than that of the natural environment. The latter poses problems since the more complicated the process becomes to prevent it, the more the chance of dilution increases. It is shown that this can be avoided by increasing the amount of sample measured. Thus, it is considered important to reduce the specimen's ^{15}N content closer to that of the natural environment rather than to introduce a wider gap between the true and the measured ^{15}N content by using samples with high ^{15}N concentration. (TCO)

22225 EXPOSITION OF DISLOCATIONS IN SINGLE CRYSTALS OF NaI(Tl). V. Ya. Zaslavskaya, R. Yu. Itskovich, and L. G. Eidel'man (All Union Inst. for Single Crystal Research, Kharkov). Soviet Phys.-Solid State (English Transl.), 6: 2516-17(Apr. 1965). Translated from Fiz. Tverd. Tela, 6: 3156-7(Oct. 1964).

A number of solvents for selective etching of NaI(Tl) to expose dislocations and substructure were investigated, including aliphatic carboxylic acids. Among the latter, glacial acetic acid, subjected to thorough drying and saturated with zinc oxide and dehydrated copper sulfate, gave satisfactory results. Using this etchant, it was found that there are marked differences in the structure of NaI(Tl) crystals grown from the melt by different methods. (D.C.W.)

22226 FIELD EMISSION MICROSCOPY OF Na ON W UNDER MIGRATION EQUILIBRIUM CONDITIONS. V. N. Shrednik and E. V. Snezhko (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 2727-37(May 1965). Translated from Fiz. Tverd Tela, 6: 3409-22(Nov. 1964).

An electron projector was used to investigate the behavior of Na on a single crystal of W at 300°K and higher, where active migration and evaporation of the Na occurs. Detailed series of field emission patterns are given, obtained by changing the mean degree of coating $\bar{\theta}$ of the tungsten by sodium from 0 to 2.2 by evaporating the Na at room temperature, as well as by setting up equilibrium between evaporation and condensation of Na at T > 400°K. Measurements were made in both cases, for known Na fluxes, of the work function (φ) as a function of $\bar{\theta}$ and T. A curve was calculated for the mean heat of evaporation $\bar{Q}(\bar{\theta})$. It was shown by further evaporation that there is an adsorption stage with a greatly reduced value of φ (down to 1.73 ev on (110)). Experiments on desorption by a field made it possible to obtain an independent value for Q in this stage. An analysis of the integrated curves $\varphi(\theta)$, $Q(\theta)$ in conjunction with the field emission patterns made it possible to find the role played by individual crystallographic regions, corresponding to different parts of the curves. (auth)

22227 COMPLEX FORMATION OF RARE-EARTH ELEMENTS WITH GLYCINE. E. E. Kriss. Ukr. Fiz. Zh., 31: 153-8(1965). (In Russian)

The first-order stability constants for complex compounds of La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Yb, Lu, and Y, and second-order stability constants for the cerium group with glycine were determined by potentiometric titration at 25°C and 0.1 ion force. (R.V.J.)

22228 ON THE RELATIVE STRENGTH OF FLUORIDE COMPLEXES OF PROTACTINIUM, NIOBIUM AND TANTALUM. R. A. Dyachkova and Victor I. Spitsyn. Ukr. Fiz. Zh., 31: 158-60(1965). (In Russian)

The relative stability of Pr, Nb, and Ta fluoride complexes was determined by measuring their optical variations with the ferrothiocyanite Fe^{3+} tracer system. Tabulated results showed the order of stability according to the bond stability between the metal cation and fluorine ion: Ta < Nb < Pr. In aqueous solutions the elements had a tendency to hydrolysis and the stability of their fluoride complexes was determined by the relative energy bond between the metal ions and competing oxygen and fluorine ions. (R.V.J.)

22229 HALOGENIDES OF RARE-EARTH ELEMENTS OF LOW OXIDATION STATE. G. I. Nobikov and O. G. Polyachenok (Leningrad State Univ.). Usp. Khim., 33: 732-47(June 1964).

A survey was made on: calorimetry of dichlorides of rare earth elements (REE); dissociation of trichlorides of samarium, europium, and ytterbium; fusibility diagrams of trichloride-rare earth metal systems; pressure of saturated vapor in trichloride-rare earth metal systems; pressure of saturated vapors of dichlorides of samarium, europium, and ytterbium; and electroconductivity and density in trichloride-rare earth metal systems. The experimental material on chemistry of halogenides of REE of low oxidation state shows that regularities found in the cerium group evidently, judging from ionization potentials and energies of sublimation of the metals are true also for elements of the ytterium group, so that diodes of all yttrium group elements can be anticipated, as well as yttrium and scandium. (CFSTI)

22230 INVESTIGATIONS OF THE STRUCTURE AND PROPERTIES OF THE NITRIDES IN IRON ALLOYS BY ISOLATION. W. Koch, K. H. Sauer, and J. Dittmann (Max Planck-Institut fur Eisenforschung, Dusseldorf, Ger. and August Thyssen-Hutte AG, Duisburg, Ger.). Z. Anal. Chem., 209: 119-31(Feb. 24, 1965). (In German)

A determination was made of properties that are essential for the presence and examination of silicon nitrides, such as solubility in solid iron at different temperatures, behavior, structure, and optical characteristics. Nitrides of chromium, vanadium, titanium, niobium, tantalum, aluminum, and boron were extracted from nitrided iron alloys by means of electrolytic isolation, and their structures and shapes were determined. As the behavior of these nitrides in acids is very important for the determination of nitrogen in steel and iron alloys, the solubility of isolated nitrides in acids was investigated. (auth)

22231 NUCLEAR MAGNETIC RESONANCE STUDIES ON FLUORIDES OF TRIVALENT PHOSPHORUS. G. S. Reddy and R. Schmutzler (E. I. du Pont de Nemours & Co., Inc., Gibbstown, N. J. and Experimental Station Lab., Wilmington, Del.). Z. Naturforsch., 20b: 104-9(Feb. 1965).

The ^{31}P, ^{19}F, and ^{1}H nuclear magnetic resonance spectra of a series of compounds of the types $(RO)_nPF_{3-n}$ and $(R_2N)_nPF_{3-n}$ (n = 1, 2) were studied. A regular change in the chemical shifts and coupling constants was observed with multiple substitution. The changes in the coupling constants are explained on the basis of the electronegativity of the atoms attached to phosphorus. Some long-range coupling constants between hydrogen and fluorine separated by five bonds were observed. (auth)

22232 SURFACE STRESS OF SOME SOLUTIONS OF NITRATES OF RARE EARTHS AND ALUMINUM. V. B. Lazarev and Yu. A. Tsylov (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 10: 22-6(Jan. 1965). (In Russian)

The surface stress of nitrate solutions of La, Nd, and Al was measured, and it was found that the specified salts are surface-inactive with respect to water. The magnitudes of the surface activity of these salts, in agreement with the theory of V. K. Semenchenko, increased in absolute size with increasing of temperature. Equations for the dependence of the surface stress of aqueous solutions of rare earth nitrates on the concentrations and temperatures were calculated. The dependence of the surface stress of tributyl phosphate and its mixtures with methylxylene on the temperature was determined and its independence of composition at 40°C was established. The surface stress of TBP and some of its mixtures with methylxylene, in equilibrium with solutions of lanthanum nitrate, was measured and it is shown that for explanation of the results obtained calculation of the interactions of all three components of the system is necessary. (tr-auth)

22233 ON THE LANTHANUM PERRHENATES. V. E. Plyushchev and M. B. Varfolomeev (Lomonosov Inst. of Fine Chemical Tech., Moscow). Zh. Neorgan. Khim., 10: 103-8(Jan. 1965). (In Russian)

The lanthanum perrhenate $La(ReO_4)_3$ and two of its crystal hydrates, the nomo- and tetrahydrates, were synthesized. The individuality of the compounds was demonstrated by chemical, x-ray, and optical analytical methods. The thermal stabilities of the lanthanum perrhenates established that the tetrahydrate in equilibrium conditions was dehydrated by 50°C to the monohydrate; the latter at 140°C was converted into anhydrous compounds, completely stable at 550°C. Some properties of the compounds synthesized were studied. (tr-auth)

22234 YTTRIUM PERRHENATES. V. E. Plyushchev and M. B. Varfolomeev (Lomonosov Inst. of Fine Chemical Tech., Moscow). Zh. Neorgan. Khim., 10: 109-14(Jan. 1965). (In Russian)

Crystal hydrates of the yttrium perrhenates, $Y(ReO_4)_3 \cdot 4H_2O$ and $Y(ReO_4)_3 \cdot 2H_2O$, were synthesized. Their thermal stabilities and some of their physicochemical properties were determined. Anhydrous yttrium perrhenate was obtained. The stability was determined in a wide temperature interval, and the physiochemical properties were studied. The existence of high-temperature modifications was established. (tr-auth)

22235 ZIRCONIUM CARBONATE COMPOUNDS. T. F. Limar and K. P. Shatskaya (Inst. of Reagents, USSR). Zh. Neorgan. Khim., 10: 115-20(Jan. 1965). (In Russian)

The solubility in ammonium carbonate solutions of zirconium carbonates and ammonia was studied. It was shown, by methods of physicochemical analysis, that the solutions, obtained by dissolution of carbonated hydroxides, contained the complex $(NH_4)_2[ZrO(CO_3)_2]$. The trihydrate of ammonium zirconyl carbonate was isolated and some of its properties are described. (tr-auth)

22236 COMPLEX COMPOUNDS OF CERIUM(IV) WITH SULFATE IONS. T. N. Bondareva, V. F. Barkovskii, and T. V. Velikanova (Ural State Univ., USSR). Zh. Neorgan. Khim., 10: 127-31(Jan. 1965). (In Russian)

In dilute sulfate solutions of tetravalent cerium, the existence of the complex cations $CeSO_4^{2+}$ was shown with $K = 2.6 \times 10^{-3}$. By increasing the concentration to 0.05M, the neutral complex $Ce(SO_4)_2$ was formed; $K_i = 5.9 \times 10^{-3}$. In solutions containing an excess of sulfuric acid, cerium essentially existed in the form of complex anions. (J.S.R.)

22237 DISSOCIATION CONSTANTS OF DI-N-CARBOXYMETHYLETHYLENEDIAMINOBISMETHYLPHOSPHINIC ACID AND INSTABILITY CONSTANTS OF ITS CHELATES WITH CERTAIN ALKALI AND RARE EARTH ELEMENTS. L. I. Tikhonova. Zh. Neorgan. Khim., 10: 132-9(Jan. 1965). (In Russian)

The dissociation constants of di-N-carboxymethylethylenediaminobismethylphosphinic (EDFK) acid in 0.1N KCl were determined at 20°C by potentiometric methods; $K_1 = 7.53 \times 10^{-7}$, $K_2 = 2.1 \times 10^{-3}$, $K_3 = 2.18 \times 10^{-5}$, $K_4 = 7.53 \times 10^{-7}$, $K_5 = 4.63 \times 10^{-7}$, and $K_6 = 1.7 \times 10^{-11}$. Simple mathematical treatments of the experimental data were suggested. The instability constants of some chelates of EDFK with Ca^{2+} and Sr^{2+} were determined by potentiometric and chromatographic methods: $K_{pot.} = 7.0 \pm 1 \times 10^{-9}$ and $K_{chrom.} = 4.9 \pm 0.3 \times 10^{-9}$ (for Sr^{2+}); $K_{pot.} = 1.2 \pm 0.3 \times 10^{-9}$ and $K_{chrom.} = 1.33 \pm 0.05 \times 10^{-9}$ (for Ca^{2+}). The instability constants of complexes of Y^{3+} and Ce^{3+} were calculated by the chromatographic method: $K_{Y^{3+}} = 9.2 \pm 0.3 \times 10^{-25} \times K_{Ce^{3+}} = 3.06 \pm 0.05 \times 10^{-19}$. EDFK forms with Y^{3+} and Ce^{3+} more stable chelates than EDTA; for Ca^{2+} and Sr^{2+} the inverse dependence of the instability constants of complexes of these ligands was observed. (tr-auth)

22238 SOLUBILITY OF LANTHANUM DIBUTYLPHOSPHATE IN SODIUM AND LANTHANUM NITRATE SOLUTIONS. Z. A. Sheka and E. I. Sinyavskaya. Zh. Neorgan. Khim., 10: 259-64(Jan. 1965). (In Russian)

According to the solubility of lanthanum dibutylphosphate in solutions of sodium nitrate, different concentrations determine the dependence of the activity coefficients of lanthanum dibutylphosphate on the ionic strength of the solution. The solubility of lanthanum dibutylphosphate in lanthanum nitrate was studied. The stability constant of the complex LaA^{2+} was determined to be 60 at $\mu = 0$ and the solubility product of the compound LaA_3 is 2×10^{-10} at $\mu = 0$. (tr-auth)

22239 COMPLEXES OF RARE EARTHS WITH COBALT, CADMIUM, AND ZINC COMPLEXONS. N. A. Skorik and V. V. Serebrennikov. Zh. Neorgan. Khim., 10: 279-81(Jan. 1965). (In Russian)

Salts of rare earths with complexones with the general formula $Lm_2(MeY)_3 \cdot xH_2O$, where Lm = La, Ce, Pr, Nd, Sm, and Gd and Me = Zn, Cd, and Co^{2+}, were prepared. The solubility of the salts in water were determined at 25°C. The solubility fluctuated for salts in the order Zn > Co^{2+} > Cd and for the lanthanides in the order Gd > Sm > Nd > Pr > Ca > La. The thermal stability of the compounds prepared was studied and it was found that at 103°C a slow loss of water occurred; in the temperature interval from 103 to 170°C the remaining water escaped; the decomposition of the organic parts took place in the interval from 300 to 400°C. (tr-auth)

22240 ENTHALPY AND HEAT CAPACITY OF RARE EARTH METAL OXIDES. D. Sh. Tsagareishvili and G. G. Gvelesiani (Inst. of Metallurgy, State Committee on Ferrous and Non-Ferrous Metals, Georgian SSR). Zh. Neorgan. Khim., 10: 319-21(Feb. 1965). (In Russian)

High-temperature enthalpy of C and B forms of Eu_2O_3, Tm_2O_3, and Yb_2O_3 (99.8 to 99.9% pure powders) was measured at temperatures from 298.1 to 1600°K. Experiments were carried out in a massive calorimeter with a copper block and isothermal shell (utrathermostat). The temperature was measured with the order of accuracy of 0.0002°C. The data obtained were used for constructing empirical equations for the enthalpy (H_T to $H_{298.1}$ cal/mole) and virtual heat capacity at constant pressure as functions of the absolute temperature (T,K°). (R.V.J.)

22241 INVESTIGATION OF BINARY URANIUM OXIDES. L. M. Kovba, E. I. Sirotkina, and V. K. Trunov (Moscow State Univ.). Zh. Neorgan. Khim., 10: 349-51 (Feb. 1965). (In Russian)

Descriptions are given of the preparation and structure of two newly synthesized binary oxides: $UNbO_5$ and UNb_2O_{10}. Elementary cell parameters for binary oxides UVO_5, $UMoO_5$, and UNb_3O_{10} constructed on the basis of $\alpha-UO_3$ structure were determined. (R.V.J.)

22242 THORIUM AQUASULFATE COMPOUNDS. A. K. Molodkin and E. G. Arutyunyan. Zh. Neorgan. Khim., 10: 352-62(Feb. 1965). (In Russian)

The genetic family of thiocyanate, formate, carbonate, oxalate, and oxalate-carbonate thorium compounds was investigated. Properties of synthesized complexes, their stability in the air, molecular electric conductivity in aqueous solutions, thermal stability, density, and refractive indexes are discussed. Data are given on the structure of sulfate complexes and on x-ray analysis of $K_4Th(SO_4)_4 \cdot 2H_2O$ and $CN_3H_6\,NaTh(SO_4)_3 \cdot 6H_2O$. A formula is suggested for potassium thorium tetrasulfates: $\{K_4[Th\mu^-(SO_4)_2\lambda^-(SO_4)(SO_4)(H_2O)_2]\}n$, called tetrapotassium diaqua-μ-disulfato-λ-(mono)-sulfato-(mono) sulfatotorate. (R.V.J.)

22243 REACTION OF CERIUM IONS WITH METHYLENE BLUE IN ACID MEDIA. A. A. Kachan and V. A. Protsenko (Belotserkovskii Agricultural Inst., USSR). Zh. Neorgan. Khim., 10: 403-6(Feb. 1965). (In Russian)

Spectrophotometric analysis of cerium (III) and (IV) sulfate reactions with methylene blue in aqueous solution of sulfuric acid indicated the possibility of the formation of a complex compound with an intermediate methylene blue oxidation product. The equilibrium shift method showed that the cerium (IV) sulfate to methylene blue ratio in reactions in aqueous sulfuric acid solutions is 2 : 1 and the instability constant is $\sim 7.1 \times 10^{-9}$. (R.V.J.)

22244 SOLUBILITY DEPENDENCE OF CERTAIN RARE EARTH CITRATES ON THE pH OF THE MEDIA. N. A. Skorik and V. V. Serebrennikov. Zh. Neorgan. Khim., 10: 407-9(Feb. 1965). (In Russian)

Solubility of Er, Gd, La, Nd, Pr, and Y citrates in perchloric acid solutions with various hydrogen ion concentrations (pH2 to 10.6) and $\mu = 0.1$ was determined. The minimum solubility of rare earth and yttrium citrates was observed at pH 5 to 6.5. Moreover, the composition of the examined citrates remained identical in liquid and solid states. With pH below 5 the solution underwent a partial reduction of complex citrate ions into simple ions and a simultaneous hydrolysis of the citrate ion. Formation of hydroxycitrato-acido-complexes $[Ln(OH)_nCit]^{-n}$ took place at pH above 6.5. (R.V.J.)

22245 ON COMPOUNDS OF RARE EARTHS AND YTTRIUM WITH VANADIC ACIDS. E. A. Arbit and V. V. Serebrennikov. Zh. Neorgan. Khim., 10: 410-13(Feb. 1965). (In Russian)

Preparation and properties of La, Pr, Nd, Sm, Eu, Gd, Dy, Ho, Lu, and Y metavanadates with the composition $Lu(V_3O_9) \cdot 4H_2O$, and La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, Ho, Er, Lu, and Y hexavanadates with the composition $(V_6O_{17})_3 \cdot 48\ H_2O$ are described. Analyses of solubilities in (pH 6.9) water at 25°C showed that the rate of solubility diminished from La to Gd and then increased to Lu. The solubility of yttrium vanadates was very similar to the solubility of dysprosium vanadates. (R.V.J.)

22246 SAMARIUM FERROCYANIDE. I. V. Tananaev and G. V. Shevchenko. Zh. Neorgan. Khim., 10: 414-20 (Feb. 1965). (In Russian)

Physico-chemical properties of trivalent samarium with Li, Na, Rb, K, and Cs ferrocyanides in aqueous solution were studied at 25°C using the solubility, electric conductivity, and electromotive force methods. Systems of $Li_4[Fe(CN)_6]$ and $Na_4[Fe(CN)_6]$ formed $Sm_4[Fe(CN)_6] \cdot 15\ H_2O$ and $NaSm[Fe(CN)_6] \cdot 3H_2O$, respectively. Mixed ferrocyanides $MSm[Fe(CN)_6] \cdot 4H_2O$ were formed with K, Rb, and Cs ferrocyanide systems. The solubilities of $Sm_4[Fe(CN)_6]_3 \cdot 15\ H_2O$, $NaSm[Fe(CN)_6] \cdot 3H_2O$, $KSm[Fe(CN)_6] \cdot 4\ H_2O$, and $RbSm[Fe(CN)_6] \cdot 4\ H_2O$ measured in water at 25°C were 1.5×10^{-5}, 1.3×10^{-5}, 2.4×10^{-4}, and 3×10^{-5} mole/l, respectively. (R.V.J.)

22247 THERMAL DISINTEGRATION OF SAMARIUM FERROCYANIDES. G. V. Shevchenko and I. V. Tananaev. Zh. Neorgan. Khim., 10: 421-4(Feb. 1965). (In Russian)

Thermographic studies were made of the thermal decomposition of normal samarium ferrocyanide and mixed samarium ferrocyanides with alkali metals (Na, K, Rb, and Cs). The data obtained indicated a slight difference in the thermal decomposition of mixed ferrocyanides except for the sodium salt, which acted differently from the other alkali metals. Anhydrous $NaSm[Fe(CN)_6]$ was unstable and disintegrated into nitride and carbide immediately after dehydration at 240°C while anhydrous salts of KSm[Fe (CN)6], $RbSm[Fe(CN)_6]$, and $CsSm[Fe(CN)_6]$ were stable up to 320°C. (R.V.J.)

22248 PHASE DIAGRAM FOR YCl_3–CsCl. D. V. Drobot, G. P. Anikina, L. V. Durinina, and B. G. Korshunov (Inst. of Fine Chemical Tech., Moscow). Zh. Neorgan. Khim., 10: 562-4(Feb. 1965). (In Russian)

A phase diagram was developed for YCl_3–CsCl containing 45.03% Y and 54.30% Cl. The melting temperatures for the yttrium and cesium chlorides were 700 and 648°C, respectively. Thermoanalysis revealed two chemical compounds: The compound CsY_3Cl_{10}, which melted congruently at 640°C with polymorphous transformation at 406°C, and the compound Cs_3YCl_6, which melted congruently at 870°C with polymorphic transformation at 412°C. (R.V.J.)

22249 OXIDATION OF UO_2 BY OXYGEN ENRICHED BY OZONE IN SULFURIC MEDIUM. G. M. Nesmeyanova and A. I. Vikulov. Zh. Prikl. Khim., 38: 28-33(Jan. 1965). (In Russian)

The comparison of the oxidizing capacity of molecular oxygen, oxygen containing ozone, and air showed that in dilute sulfuric acid solutions (1 to 10 g/l) oxygen, enriched with ozone, was considerably more effective than oxidizers such as $KClO_3$, MnO_2, and HNO_3. Simultaneously it was shown that in the specified concentration intervals of the sulfuric acid and at high temperatures molecular oxygen oxidized uranium to a greater degree than potassium chlorate or nitric acid. In the presence of solutions of iron compounds at 20°C and sulfuric acid concentrations of 10 g/l (optimum for ozone) air containing ozone completely oxidized uranium; with oxidizers such as MnO_2, $K_2Kr_2O_7$, $KClO_3$, and $KMnO_4$ this was impossible to attain. At 70°C, oxygen or air containing ozone oxidized uranium to a greater degree than the oxidizers mentioned above. (tr-auth)

22250 CRYSTALLINE YTTRIUM HYDROXIDES. P. V. Klevtsov, R. F. Klevtsova, and L. P. Sheina (Inst. of Inorganic Chemistry, Novosibirsk, (USSR). Zh. Strukt. Khim., 5: 583-9(1964).

Transparent colorless crystalline phases previously observed in the products of hydrothermal synthesis of yttrium ferrite single crystals were identified as yttrium hydroxides, YOOH and $Y(OH)_3$. The crystal structure of these hydroxides was studied goniometrically and by x-ray diffraction, chemical analysis, and other methods. The YOOH and $Y(OH)_3$ single crystals used in the study were synthesized under hydrothermal conditions from either the Y_2O_3–Fe_2O_3–H_2O–NaOH or the Y_2O_3–H_2O–NaOH system. Most of the YOOH single crystals were in the form of hexagonal plates belonging to the prismatic class of the monoclinic crystal system and to the $P2_1/m$ space group. Typical $Y(OH)_3$ single crystals were needle-shaped, 1 cm × ~0.6 mm, belonging to the hexagonal system and to the $P6_3/m$ space group. Dimensions of the unit cell were determined for both hydroxides. The piezoelectric effect was not detected in freshly prepared YOOH or $Y(OH)_3$ crystals. The x-ray diffraction patterns of $Y(OH)_3$ crystals were found to be similar to those of $M(OH)_3$, where M is La, Nd, Sm, Gd, or Er. It was concluded that only two crystalline phases, $Y(OH)_3$ and YOOH, are formed, individually or simultaneously, in the Y_2O_3–H_2O–NaOH system below 600°C. (CFSTI)

22251 ELECTRON DIFFRACTION INVESTIGATION OF O_2, $N_2(CF_3)_4$, AND DEUTERIUM ISOTOPE EFFECTS IN C_2H_6 AND CH_3NH_2. Harlan Kieth Higginbotham. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 91p.

The structure of oxygen was determined to test the absolute significance of modern electron diffraction parameters. The parameters r_e and l_α were found to be 1.2074 Å and 0.0389 Å with standard errors of 0.0011 Å and 0.0010 Å, respectively. The good agreement between these and spectroscopic results indicates that current interpretational schemes are quite rigorous for diatomics, and it is reasonable to conclude that mean distances for polyatomic molecules can be obtained with comparable accuracy when the radial distribution peaks are widely separated. Perfluorotetramethylhydrazine was studied. The bond distances measured were found to be in general agreement with those for related compounds. Considerable bond angle distortion was observed as the crowded molecule deformed to achieve normal van der Waals separations between fluorines in different groups. Ethane, methylamine, and their deuterated analogs were investigated to determine the magnitudes of primary and secondary isotope effects on mean bond lengths. Three individual studies of the ethanes were carried out and the analysis gave a primary deuterium effect of 0.0050 ± 0.0006 Å. They also indicated a weaker secondary effect of 0.0016 ± 0.0007 Å. Primary isotope effects in the methylamines were evident in the radial distribution functions but the magnitudes were not determined because the NH and CH bond lengths were too close to be resolved. No significant secondary isotope effect in the methylamines was observed but the uncertainty in the determination did not exclude an effect of 0.006 Å or less. (A.G.W.)

22252 THE MICROWAVE SPECTRA OF "CIS" DIFLUORODIAZINE AND THE ISOMERS OF SULFUR MONOFLUORIDE. Robert Louis Kuczkowski. Thesis, Cambridge, Mass., Harvard Univ., 1964. 107p.

The microwave spectrum of $FN^{14}N^{14}F$ in the ground state and an excited vibrational state and $FN^{14}N^{15}F$ are reported. From the two isotopic species the structure was derived as planar "cis" FNNF with d(NF) = 1.384 ± 0.01Å, d(NN) = 1.214 ± 0.005Å, and ∠NNF = 114.5° ± 0.5°. The excited vibrational state had a frequency of 300 ± 35 cm^{-1}. An argument is presented to assign this frequency to the symmetrical N-F bending mode. The dipole moment was measured as 0.16 ± 0.01 D. A method of obtaining the nuclear spin statistical weight ratios from the relative intensities of partially modulated transitions in a Stark effect

spectrometer is described and applied to "cis" N_2F_2. A discussion of the structure is presented. The volatile reaction products from heating sulfur and silver (I) fluoride were shown to produce two "new" species of different chemical reactivity. The less reactive compound was isolated by fractional distillation. The mass spectrum of this compound and the microwave spectra of three isotopic species are reported. The compound was identified as pyramidal S = SF_2 with d(SS) = 1.860 ± 0.015Å, d(SF) = 1.598 ± 0.012Å, ∠SSF = 107.5 ∓ 1° and ∠FSF = 92.5 ± 1°. The dipole moment was 1.03 ± 0.03. A technique is described to prepare the more reactive compound in large yields. Its mass spectrum and the microwave spectrum of two isotopic species are reported. The nuclear spin statistical weight factors were investigated for both isotopes. The data permitted the reactive compound to be identified as nonplanar chain FSSF with d(SF) = 1.635 ± 0.01Å, d(SS) = 1.888 ± 0.01Å, ∠SSF = 108.3° ± 0.5° and dihedral angle of 87.9° ∓ 1.5°. The dipole moment was 1.45 ± 0.02Å. The structure of these two isomers of S_2F_2 is discussed. (Dissertation Abstr., 25: No. 5, Nov. 1964).

22253 SYMPOSIUM ON CARBON, JULY 20-23, 1964, NIPPON TOSHI CENTER, TOKYO. Tokyo, Carbon Society of Japan, 1964. 390p. (CONF-640703)

Papers presented at the Symposium on Carbon, Tokyo, July 20 to 23, 1964 are given. Topics covered include: solid-state physics of graphite and diamond, organic solids, carbonization, graphitization, crystal structure, electronic properties of carbons, thermal and mechanical properties of carbons, lattice defects and radiation effects, pore structure and permeability, reactivity, and carbon technology, uses, and applications. Separate abstracts were prepared for 21 of the 90 papers. (M.C.G.)

For abstracts of individual papers see: 22254, 22255, 22386, 22909, 22910, 22911, 22912, 23098, 23099, 23100, 23101, 23102, 23103, 23152, 23153, 23154, 23155, 23156, 23984, 23985, and 23986.

22254 MEASUREMENT OF CHEMISORBED OXYGEN LEFT ON GRAPHITE AFTER DEGASSING. H. Hering, H. Le Bail, J. Sutton, and A. Vanderchmitt (Commissariat a l'Energie Atomique, Gif sur Yvette, France). Session VIII, Paper 9 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

The efficiency of surface oxide removal from graphite at 900°C under vacuum was investigated by tracer studies using ^{18}O. It was concluded that degassing at 900 or 950°C takes practically all of the chemisorbed oxygen and that CO_2 produced during the degassing of industrial graphite samples at temperatures above 1000°C must have an origin different from chemisorbed oxygen. (M.C.G.)

22255 CHEMISORPTION OF OXYGEN ON GRAPHITE AS FOLLOWED BY THERMOELECTRIC POWER MEASUREMENTS. P. L. Walker, Jr., L. G. Austin, and J. J. Tietjen (Pennsylvania State Univ., University Park). Session VIII, Paper 12 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 5p.

Studies of the kinetics of oxygen chemisorption by graphite by changes in thermoelectric power (α) were considered. Degassed graphite samples were exposed to 1 atm of O_2 at 608 to 725°K, and α measured. Data are shown in graphs. (M.C.G.)

22256 GREEN SALT PLANT (Engineering Materials). (National Lead Co. of Ohio, Cincinnati). 50 drawings. (CAPE-51)

In the Green Salt Plant, uranium trioxide (UO_3) is converted to uranium tetrafluoride (UF_4), or green salt, by a two-step, continuous process. In the first step, UO_3 is converted to uranium dioxide (UO_2) by reduction with hydrogen. In the second step, UO_2 is converted to UF_4 in a reaction with anhydrous hydrogen fluoride. Hydrofluorination takes place in three horizontal screw reactors arranged in a vertical stack. The hydrofluorination reactors are 16-in.-dia tubes about 22 ft in length. Each reactor is enclosed by electric furnaces. Powder is conveyed through the reactors by a lawn-mower type, variable-speed screw rotor equipped with special pusher blades to provide mixing and forward motion to the powder. The reactant gases in each system are kept separate by seal hoppers with the solids powder used as a sealant. Facilities are provided to pulverize, blend, and package the UF_4 product. (For details, see TID-4100) (M.C.G.)

22257 FLUORINATION PLANT FOR MANUFACTURE OF UF_6 (Engineering Materials). (Union Carbide Corp., Paducah, Ky. Paducah Plant). 59 drawings. (CAPE-54)

Uranium tetrafluoride (UF_4) is converted to uranium hexafluoride (UF_6) in a highly exothermic reaction, shown as follows: $UF_4(s) + F_2(g) = UF_6(g)$ + 112,000 BTU/lb. mole U. The UF_6 production line consists generally of a vertical, water-cooled flame reactor, sintered metal filters, heat exchangers, a fluorine cleanup reactor and an ejector for inert gas removal. Gaseous UF_6 is produced by treating UF_4 with preheated F_2 in the water-cooled flame reactor. The gas is filtered and chilled to a solid in a refrigerated heat exchanger. The solid is liquefied under pressure and drained into ten-ton product cylinders. This process lends itself to highly automated mass production techniques. Chemical efficiencies are high; the F_2 efficiency is 99% and the uranium yield is greater than 99%. The product is 99.9% pure UF_6. (For details, see TID-4100) (M.C.G.)

22258 VIBRONIC SPECTRUM OF Eu^{3+} IN STRONTIUM TITANATE. M. J. Weber and R. F. Schaufele (Raytheon Co., Waltham, Mass.). 27p. (CONF-641004-9)

From American Physical Society Meeting, Chicago.

Vibrational satellite structure is observed in the fluorescence spectrum of Eu^{3+} in $SrTiO_3$. Selection rules for one-phonon vibronic transitions involving phonons at $\vec{k} = 0$ and other special points in the Brillouin zone were derived and used in assigning the vibronic peaks to various modes in the lattice vibrational spectrum. All branches appeared to contribute to the vibronic structure. The frequencies of peaks in the vibronic spectrum agreed generally with known or predicted lattice vibrational frequencies of $SrTiO_3$. By observing the vibronic line corresponding to the lowest transverse optical branch, the frequency shift with temperature of this branch was measured between 130 and 350°K and is discussed. The structural phase transition of $SrTiO_3$ was evident from the appearance of additional fluorescence lines for temperatures below ~110°K. The absence of additional crystal-field splitting of the spectrum indicated that the non-cubic distortions associated with the phase transition are small. (auth)

22259 NUCLEAR MAGNETIC RELAXATION IN MAGNETITE. T. Mizoguchi and Y. Tomono (Tokyo Univ.). 10p. (CONF-794-6)

From Magnetism Conference, Minneapolis, Nov. 1964.

The nuclear magnetic relaxation of ^{57}Fe on tetrahedral sites in polycrystalline magnetite was studied by the spin echo method with special emphasis on the relation to the low-temperature transition and electron diffusion among octahedral sites. Spin-lattice relaxation time T_1 increased from about 0.7 msec at room temperature to 9 msec at 130°K. At the transition point (118°K) T_1 decreased abruptly by the factor of about seven. It had a minimum of 0.6 msec at about 88°K, then increased with decreasing temperature up to about 90 msec at 4.2°K. The minimum of T_1 may be interpreted by the electron diffusion among the B site. This effect was considered to be dominant below the transition temperature to liquid N_2 temperature. The discontinuity of the relaxation temperature in time at the transition temperature suggested that the electron transition frequency increases discontinuously in the disordered state and does not affect the nuclear magnetic relaxation. Spin-spin relaxation time T_2 was equal to T_1 above about 60°K and smaller below that temperature. T_2 = 10 msec 4.2°K may be attributed to Suhl's interaction. (auth)

22260 LIGAND EXCHANGE IN β-DIKETONE COMPLEXES OF ZIRCONIUM(IV), HAFNIUM(IV), AND THORIUM(IV). A. C. Adams and E. M. Larsen (Univ. of Wisconsin, Madison). 19p. (CONF-571-28)

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

Proton nuclear magnetic resonance showed that solutions containing metal acetylacetonates, $M(CCA)_4$, and metal trifluoroacetylacetonates, $M(CTA)_4$, (where M is Zr, Hf, or Th) exhibit ligand exchange. The equilibrium mixtures contain $M(CCA)_4$, $M(CCA)_3(CTA)$, $M(CCA)_2(CTA)_2$, $M(CCA)(CTA)_3$, and $M(CTA)_4$. The mole fractions for each of these species and the equilibrium quotients for the exchange reactions were calculated from the areas of the resonances. A comparison of the measured mole fractions with the mole fractions calculated for a random distribution of the ligands showed that the concentrations of the "mixed" compounds are greater than the calculated values. The rate of ligand exchange in the system was the same for zirconium and hafnium; however, the rate was about ten times faster for thorium. The rate of exchange between the free ligand and the metal chelate was measured by nuclear magnetic resonance line broadening techniques. The rate increased in the order Hf ≲ Zr ≪ Th. The exchange of CTA groups obeyed second order kinetics; however, the CCA exchange was first order when benzene was the solvent, but second order when the compounds were dissolved in chlorobenzene. (auth)

22261 PRODUCTION OF HIGH-PURITY SINTERABLE BERYLLIUM OXIDE. (to Brush Beryllium Co.). British Patent 975,330. Nov. 18, 1964. Priority date July 28, 1960, United States.

A process for manufacturing BeO consists of intimately mixing by mechanical blending one or more gas-forming agents with $BeSO_4 \cdot 4H_2O$, heating the mixture to a temperature range of 875–1000°C, and maintaining the temperature within this range until the sulfate is calcined and converted to BeO. The gas-forming agent may be either urea, ammonium oxalate, ammonium acetate, ammonium sulfate, or a mixture of any of these. The mixture for calcining is made up of 1 to 30 wt % $BeSO_4 \cdot 4H_2O$ and 1 to 25 wt % of the gas-forming agent depending upon which agent is used. This process is applicable to the production of large batches of substantially pure BeO and yields a BeO capable of being sintered to substantially theoretical density subsequent to room-temperature compaction. (A.G.W.)

22262 METHOD OF PRODUCING THORIUM OXIDE AND MIXED OXIDES WITH A HIGH CONTENT OF THORIUM OXIDES. Paul Rombeau and Marcel Peltier (to Pechiney, Compagnie de Produits Chimiques et Electrometallurgiques). German Patent 1,178,409. Sept. 24, 1964. Priority date June 28, 1961, France.

The method consists of reacting thorium oxalate with a concentrated, hot ammonium solution, separating the hydroxy oxalate obtained, treating the hydroxy oxalate with an acid solution with a pH of less than 5 for at least half an hour at about 80 to 100°C, stirring the suspension formed at 60°C with an ammonia solution for about 10 minutes, and washing, drying, and calcining the hydroxy oxalate after a pH between 6 and 9 is attained. (Gmelin Inst.)

22263 METHOD OF PRODUCING ALKALI OR ALKALINE EARTHS URANIUM(IV) FLUORIDES OF HIGH PURITY FOR NUCLEAR PURPOSES. Alberto Cacciari, Ruggero de Leone, Carlo Fizzotti, and Mario Gabglio (to Comitato Nazionale per l'Energia Nucleare). German Patent 1,178,836. Oct. 1, 1964. Priority date Feb. 22, 1957, Italy.

The fluorides are obtained from uranyl nitrate in a watery solution. The method consists of turning uranyl nitrate into uranyl sulfate or chloride, reducing the uranyl salt solution obtained to uranium(IV) salt, reacting the compound obtained with hydrofluoric acid, transforming the solution thus obtained into the alkali or alkaline earth uranium(IV) fluorides, and extracting the precipitated compound from the solution. (Gmelin Inst.)

Organic Chemistry

22264 (IS-T-8) ELECTRON DIFFRACTION STUDY OF NH_3, ND_3, ISOBUTYRALDEHYDE, AN N_2O_3–HF COMPLEX, AND SEVERAL CYCLOPROPANE DERIVATIVES (thesis). Jack Paul Guillory (Ames Lab., Iowa State Univ. of Science and Tech.). 1965. Contract W-7405-eng-82. 74p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The structural parameters of ammonia and deuteroammonia were determined for comparison with the corresponding spectroscopic values. Excellent internal agreement between the results from the least squares f(r) and least squares intensity methods was achieved. The analysis of cyclopropyl carboxaldehyde yielded normal values for bond angles and amplitudes of vibration and revealed no tendency of the aldehyde to assume a nonclassical structure of the sort hypothesized for its analog, the cyclopropyl carbinyl cation. It was found that the vapor consisted of essentially an equal mixture of s-cis and s-trans conformers. This behavior was rationalized in terms of the π-electron character of the cyclopropane ring. The 2-fold barrier hindering rotation of the aldehyde group was also estimated and found to be greater than 2.5 kcal/mole. For cyclopropyl methyl ketone, an equilibrium concentration of 80% s-cis isomer and 20% of an antigauche-distorted trans distribution was found. The $H_M \cdots H_R$ nonbonded repulsions apparently destabilize the trans configuration. The equilibrium concentration of cyclopropane carboxylic acid chloride consists primarily of a broad distribution of twist isomers in the approximate range $-30° \leq \phi \leq +30°$ and is distinctly non-Gaussian in shape. The $Cl \cdots H_R$ nonbonded in the 0°-twist conformer destabilizes this planar isomer and is probably responsible for the broad and flat shape of the twist distribution. The isomeric content of isopropyl carboxaldehyde, which may be considered to be a key fragment of 2-methylcyclohexanone, was found to be 90% gauche and 10% s-trans. This implies a stabilization resulting from the eclipsing of a methyl group by a carbonyl group. The barrier to rotation of the aldehyde group was estimated to be in excess of 2.5 kcal/mole. A 68°C constant boiling complex was studied by the electron diffraction technique. Analysis indicated that the vapor composition corresponded to $NO_2 + NO + 12.6HF$. The experimental N, O··O, and HF internuclear distances in the sample were in good agreement with the values reported for independent determinations of NO_2, NO, and HF molecules. (P.C.H.)

22265 NMR STUDY OF THE ROH-D_2O SYSTEMS. I. ETHANOL, PROPANOL-1, PROPANOL-2. B. Cernicki (Organic Chemical Industry OKI, Zagreb). Ber. Bunsenges. Physik, Chem., 69: 57-60(1965).

The NMR spectra of mixtures of ethanol, propanol-1, and propanol-2 with heavy water are discussed. The intensities of the hydroxyl and water signals were found to agree with the theoretical probability curves. No coalescence of these signals could be found up to molar fraction of D_2O equal to 0.9. The spectra of ROH–D_2O systems are shown to be more representative of water–alcohol mixtures than are those of ROH–H_2O systems. (auth)

22266 INVESTIGATIONS OF THE SYNTHESIS OF DL-N^{15}-β-METHYLASPARTIC ACID. G. A. Galegov, M. A. Sergeeva, and S. R. Mardashev (Inst. of Biological and Medical Chemistry, Moscow). Biochemistry (USSR) (English Transl.), 29: 428-31(May-June 1964). Translated from Biokhimiya, 29: 497-501(May-June 1964).

The preparation of DL-^{15}N-β-methylaspartic acid was accomplished by condensation of α-bromopropionic ester and ^{15}N-acetylaminomalonic ester. Preparation of the labeled ester was carried out by reaction of $K^{15}NO_2$ with malonic ester and acetic acid, followed by reaction with acetic anhydride. The labeled methylaspartic acid was used to prepare other amino acids. (M.C.G.)

22267 THE MECHANISM OF THE DIELS-ALDER REACTION OF 2-METHYLFURAN WITH MALEIC ANHYDRIDE. Stanley Seltzer (Brookhaven National Lab., Upton, N. Y.). J. Am. Chem. Soc., 87: 1534-40(Apr. 5, 1965). (BNL-8060)

Five different deuterated isomers of the exo adduct formed from 2-methylfuran and maleic anhydride were synthesized and their rates for retro Diels-Alder reaction in isooctane at about 50°C were determined. From

the nature of these secondary α- and β-deuterium isotope effects, it was concluded that the two bonds formed between diene and dienophile are ruptured in a concerted process in the reverse Diels-Alder reaction. The nuclear magnetic resonance spectra of these compounds are discussed. (auth)

22268 EFFECT OF STRUCTURAL CHANGES IN REACTANTS ON THE POSITION OF HYDROGEN-BONDING HYDROGENS AND SOLVATING MOLECULES IN TRANSITION STATES. FROM MECHANISM OF TETRAHYDROFURAN FORMATION FROM 4-CHLOROBUTANOL. C. Gardner Swain, David A. Kuhn, and Richard L. Schowen (Massachusetts Inst. of Tech., Cambridge). J. Am. Chem. Soc., 87: 1553-61(Apr. 5, 1965). (MIT-905-29)

Reasons are advanced for expecting that a proton being transferred in an organic reaction from one oxygen (or nitrogen) to another should lie in an entirely stable potential at the transition state and be closer to the more basic atom, but increasingly remote as substituents are changed to make this atom less basic. This solvation rule predicts no ordinary primary isotope effect for such hydrogens, and a dependence of position on structure of the reactants, which is opposite to that for hydrogens that separate reacting bonds, e.g., the α-hydrogens of ketones undergoing enolization, which follow the reacting-bond rule previously proposed. However, secondary hydronium ($DO^+ + HO \rightarrow DO + HO^+$) or hydroxide ($DO^- + HO \rightarrow DO + HO^-$) isotope effects cannot be ignored. The simplest procedure for calculating them is described. The k_H/k_D isotope effects in the reactions of water or hydroxide ion with 4-chlorobutanol to form tetrahydrofuran are quantitatively interpretable as secondary and solvent isotope effects, with no ordinary primary isotope effect from the alcoholic hydrogen being transferred. The change in structure of the transition state for reaction of hydroxide ion with 2-chloroethanol is in accord with the reacting-bond rule. A fundamental fallacy in anthropomorphic arguments used to choose among reaction mechanisms is illustrated by the hydrolysis of Schiff bases. The decomposition of hyponitrous acid, the Cannizzaro reaction, the benzilic acid rearrangement, and the alkaline cleavage of 2,6-dihalobenzaldehydes illustrate further the method for calculating isotope effects from assumed transition states. (auth)

22269 DETERMINATION BY NEUTRON AND X-RAY DIFFRACTION OF THE ABSOLUTE CONFIGURATION OF AN ENZYMATICALLY FORMED α-MONODEUTERIOGLYCOLATE. Carroll K. Johnson (Oak Ridge National Lab., Tenn.), Eric J. Gabe, Max R. Taylor, and Irwin A. Rose. J. Am. Chem. Soc., 87: 1802-4(Apr. 20, 1965). (ORNL-P-1104)

The absolute configuration of the α-monodeuterioglycolate ion produced by the action of the muscle lactic dehydrogenase on deuterioglyoxylate ions was determined. Crystals of the ^{6}Li salt were studied by x-ray diffraction methods. However, since hydrogen and deuterium have the same atomic number they could not be distinguished by x-ray analysis. Therefore, neutron diffraction measurements were made using a neutron wavelength of 1.078Å. (M.C.G.)

22270 ELECTRON-DIFFRACTION STUDY OF THE STRUCTURES OF C_2H_4 AND C_2D_4. L. S. Bartell (Ames Lab., Ames, Iowa), E. A. Roth, C. D. Hollowell, Kozo Kuchitsu, and J. E. Young, Jr. J. Chem. Phys., 42: 2683-6(Apr. 15, 1965). (IS-1003)

The structures of ethylene and deuteroethylene were investigated by electron diffraction to resolve apparent discrepancies between earlier diffraction and spectroscopic studies. Satisfactory agreement with the previous diffraction study was found for five of the six molecular parameters determined but a difference of five standard deviations was encountered for the C–H bond length. Mean bond lengths and standard errors for C_2H_4 obtained were $r_g(CH) = 1.103 \pm 0.001$ and $r_g(CC) = 1.336 \pm 0.001$Å. Corresponding lengths for C_2D_4 were $r_g(CD) = 1.099 \pm 0.003$ and $r_g(CC) = 1.338 \pm 0.003$Å. Bond angles, corrected for shrinkage effects, were $\angle CCH = 121.4 \pm 0.6$ and $\angle CCD = 121.4 \pm 0.8°$. These diffraction results were compared with mean bond lengths and angles calculated from spectroscopic rotational constants taking rotation–vibration interactions into account. Excellent agreement was found. Significant differences existed, however, between the conventional bond-length parameters derived by spectroscopy and diffraction. Root-mean-square amplitudes of vibration were also determined by diffraction, and these agreed satisfactorily with amplitudes calculated from vibrational frequencies. (auth)

22271 RADIATIONLESS TRANSITIONS AND DEUTERIUM EFFECT ON FLUORESCENCE LIFETIMES OF SOME AROMATIC HYDROCARBONS. Joseph D. Laposa (Loyola Univ., Chicago), E. C. Lim, and R. E. Kellogg. J. Chem. Phys., 42: 3025-6(May 1, 1965).

The fluorescence lifetimes of several perprotonated and perdeuterated aromatic hydrocarbons were measured in rigid media at 77°K. Within experimental error, no change was found in lifetime on substitution of deuterium for protium. It was concluded from this result that radiationless first-excited singlet to ground singlet ($S_1 \rightarrow S_0$) transitions are unimportant in these systems. The fluorescence lifetime of anthracene at room temperature also compared favorably with that at low temperature, suggesting strongly that $S_1 \rightarrow T_1$ (first excited singlet to lowest triplet) radiationless processes in aromatics are temperature independent. (auth)

22272 ANALYSIS OF EMISSION SPECTRA OF THE BENZYL RADICAL WITH AND WITHOUT DEUTERIUM SUBSTITUTIONS. L. Grajcar and S. Leach (Université de Paris, Orsay, France). J. Chim. Phys., 61: 1523-30 (Nov.-Dec. 1964). (In French)

The fluorescence spectra of the benzyl radicals $C_6H_5CH_2$, $C_6H_5CD_2$, and $C_6D_5CD_2$ and that of the toluene molecule $C_6H_5CH_3$ were observed in solid solution in cyclohexane at 77°K. It was verified, by a comparative study of the emission spectra of toluene in polycrystalline matrix and in gaseous phase, that the solute, trapped in the monocrystalline lattice of cyclohexane, can be considered in the first approximation as an oriented gas. Analysis of the spectra of the isotopic benzyl made it possible to attribute the frequencies observed to different normal vibration modes. It was determined that the transition is of the $^2A_2 - {}^2B_2$ type, with the benzyl belonging to the C_{2v} symmetry group. The vibration structure is analogous to that of the $^1B_1 - {}^1A_1$ transition of toluene. The value 22,002 cm^{-1} for the 0,0 band was confirmed and analysis of the emission of the benzyl radical in the gaseous phase was made more precise. The existence in the case of toluene of a vibration of frequency 122 cm^{-1} was shown. It is attributed to the torsion of the methyl grouping around its bonding to the benzene nucleus. (tr-auth)

22273 PREPARATION OF ^{3}H-VITAMIN D_3, USING COLUMN AND THIN-LAYER CHROMATOGRAPHY. C. K. Parekh and R. H. Wasserman Cornell Univ., Ithaca, N. Y.). J. Chromatog., 17: 261-6(Feb. 1965).

Tritium-labeled vitamin D_3 was prepared by two different methods, the tritiation of 7-dehydrocholesterol by the Wilzbach procedure with subsequent conversion to vitamin D_3 and the direct tritiation of vitamin D_3 at −190°C under nitrogen. A combination of column and thin-layer chromatographic procedures were necessary to purify the product resulting from the first procedure, primarily due to the presence of a pink by-product (after $SbCl_3$ treatment) arising from the degradation of 7-dehydrocholesterol. Purification of the product resulting from the second procedure could be affected on thin-layer chromatographic plates alone. A solvent is described, which increases the degree of separation of vitamin D_3 and 7-dehydrocholesterol on TLC plates. (auth)

22274 NEW SYNTHESIS OF L-XYLOSE-5-t. Susanne von Schuching and Glenn H. Frye (Veterans Administration Center, Martinsburg, W. Va.). J. Org. Chem., 30: 1288-91 (Apr. 1965).

A method was developed for preparation of L-xylose la-

beled with tritium at the C-5 position. The compound 1,2:3,5-di-O-cyclohexylidene-L-xylofuranose was hydrolyzed to 1,2-mono-O-xylofuranose. Catalytic oxidation of this compound gave 1,2-mono-O-cyclohexylidene-L-xyluronic acid. The methyl ester of this acid was prepared and the ester group reduced with tritiated sodium borohydride. Purification of the 1,2-mono-O-cyclohexylidene-L-xylofuranose-5-t after reduction was carried out by ion exchange. The L-xylose-5-t obtained from hydrolysis of this compound was isolated with carrier L-xylose in a 52% radiochemical yield. (M.C.G.)

22275 CARBON-13 ISOTOPE EFFECTS IN THE OXIDATION OF ACETIC ACID. Mieczyslaw Zielinski (Univ. of Chicago). J. Phys. Chem., 69: 1428-9(Apr. 1965).

Discrepancies in investigations of isotope effects on the oxidation of ^{14}C-labeled acetic acid were studied by oxidation of acetate containing ^{13}C at the natural abundance level. Where k, is the specific rate constant for the oxidation of $^{12}CH_3{}^{12}COOH$ and k_2 that for $^{12}CH_3{}^{13}COOH$, it was found that $k_1/k_2 = 1.0098 \pm 0.0030$. The results were consistent with earlier findings that there is an appreciable kinetic isotope effect associated with the oxidation of ^{14}C-labeled acetic acid. (M.C.G.)

22276 COMPARISON OF WATER SORPTION AND DEUTERIUM–HYDROGEN EXCHANGE SITES IN POLY-L-VALINE. W. W. Brandt and R. S. Budrys (Univ. of Chicago). J. Phys. Chem., 69: 1432-4(Apr. 1965).

Deuterium-hydrogen exchange experiments were carried out on two poly-α-amino acids in order to determine if sorption and exchange sites are identical. Samples of poly-L-valine and poly-L-leucine were degassed and exposed to D_2O vapor. Results were plotted as the number of moles of D exchanged per polymer repeat unit against the cumulative time of exposure. There was a definite correlation between sorption and exchange, but a dependence of exchange capacity on polymer secondary structure was concluded. (M.C.G.)

22277 APPARATUS FOR MEASUREMENT OF THE THERMAL CONDUCTIVITIES OF ELECTRIC NON-CONDUCTOR FLUIDS. R. Bessouat, H. Chavanel, and S. Elberg (Centre d'Etudes Nucleaires, Grenoble, France). J. Phys. (Paris), 26: 1A-6A(Jan. 1965). (In French)

An apparatus built for the study of organic coolants for nuclear reactors is described. It uses a nonstationary wire method. The equipment works almost fully automatically in order to minimize reading errors. It allows measurements up to 500°C and 20 atmospheres. Toluene was used for calibration. The accuracy on thermal conductivity determination relative to that of toluene is estimated to be of the order of ±1.5%. Results of measurements made with terphenyls OM_2 and OMP and with coolants of petroleum origin are given. (auth)

22278 BRANCHING IN POLY(BUTADIENE-CO-STYRENE). I. BRANCHING DETERMINED BY VISCOMETRY AND ULTRACENTRIFUGATION. J. Blachford and R. F. Robertson (McGill Univ., Montreal). J. Polymer Sci. Pt. A, 3: 1289-1302(Apr. 1965).

A sample of poly(butadiene-co-styrene), SBR, was divided into twelve fractions by precipitation from a dilute benzene solution. The intrinsic viscosities $[\eta]$ and weights of all the fractions were measured, and the sedimentation coefficients s_0 were determined for the nine fractions of highest molecular weight. From the values of $[\eta]$ and s_0 the number of crosslinks per molecule m, was calculated for each fraction. The results indicated that only the four fractions of highest molecular weight contained crosslinked molecules. The number of crosslinks per weight-average primary (prior to crosslinking) molecule for the entire sample, δ_0, was obtained from the weights of the fractions and the values of m. By use of various theories, values of δ_0 of 0.78, 0.56, and 0.38 were obtained. From the values obtained for $[\eta]$ and s_0 and the pycnometric partial specific volume of the polymer in benzene, the molecular weights M of the nine fractions of highest $[\eta]$ were calculated. The molecular weights of the remaining fractions were calculated from the relation between M and $[\eta]$ obtained by others. A molecular weight distribution curve was established and used to obtain $\delta_0 \leq 0.36$. (auth)

22279 THE 3000-3900 cm^{-1} ABSORPTION BANDS AND ANELASTICITY IN CRYSTALLINE α-QUARTZ. D. M. Dodd and D. B. Fraser (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Chem. Solids, 26: 673-86(Apr. 1965).

Studies are reported of the 3000 to 3900 cm^{-1} absorption spectra of natural and synthetic α-quartz at ~77°K and of the 5-mc anelastic loss peak near 100°C. The absorption spectra of natural quartz samples before and after various treatments were in general agreement with those reported by other workers and the conclusions based on absorption results were consistent with those derived from the acoustic studies. The behavior of synthetic quartz, presumably because of other defect structures and the presence of more numerous and extensive disordered regions, varied in some respects. The data indicated that, in contrast to natural quartz, Li^+ incorporated during growth of synthetic quartz enters sites that are different from those involved when Li^+ is introduced by electrodiffusion. Furthermore, for a crystal, which was rapidly grown in a Li–Al doped NaOH solution, the data signified more alkali near the edge and more bonded OH near the seed. The absorption characteristics before and after heat treatment of a rapidly grown synthetic showed that the inclusions causing milkiness contained ordered water. Moreover, the good correlation found between anelastic loss and extinction coefficient was interpreted to mean that the high-temperature relaxation peak is due to hydrogen bonded OH and not to an aluminum silicate as postulated previously. (auth)

22280 THE STABILITY OF LABELLED ORGANIC COMPOUNDS. R.C.C. Review 3. Amersham, Bucks, Eng., The Radiochemical Centre, 1965. 15p. Free.

The stability of labeled organic compounds is discussed from the point of view of the users of labeled compounds. Self-decomposition is regarded as a troublesome phenomenon, to be studied only in order to reduce its magnitude. Primary internal and external radiation effects and secondary radiation effects are described. The choice of diluent, effects of impurities, effects of temperature, methods of handling and sampling, use of free radical scavengers, chain reactions, and effects of radiation characterictics are discussed. Decomposition independent of radiation is also considered. Examples of the decomposition of labeled molecules are given. Precautions for use in handling or storing radioactive organic compounds are summarized. Decomposition during experiments is also considered. (M.C.G.)

Radiation Chemistry

See *also* BIOLOGY AND MEDICINE — Radiation Effects.

Refer also to abstracts 21819, 21820, 22865, 23355, 23972, and 24160.

22281 (BNL-8195) ESR SPECTROSCOPY OF IRRADIATED ACRYLAMIDE. G. Adler and J. H. Petropoulos (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 14p. (CONF-571-34). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

ESR spectroscopy at low temperature shows that the acrylamide scavenges hydrogen formed in the radiolytic process. The resulting radical is essentially similar to the one formed in the radiolysis of propionamide. Unlike the results obtained during room temperature irradiation, the ESR spectrum observed on single crystals at low temperatures shows a strong dependence on crystal orientation. The spectrum changes slowly between −150°C and −30°C. The nature of the change and some other data indicate that this may be due to addition of one or at most two monomer units to the radical, probably reaction with the nearest

neighbor in the crystallographic b axis. At approximately −30°C, the orientation dependence of the spectrum tends to disappear and the signal observed begins to look like that observed in room temperature irradiation. This indicates that polymerization is now taking place and that the resulting polymer is amorphous. The data can be interpreted as indicating that although the first steps of the process are probably constrained to a given crystallographic direction, polymerization proceeds only at those temperatures where annealing takes place and the polymer can become amorphous. This is consistent with the previous picture of this reaction. (auth)

22282 (NYO-1930-40) RESEARCH IN NUCLEAR AND RADIOCHEMISTRY. Progress Report for Year Ending January 31, 1965. T. T. Sugihara (Clark Univ., Worcester, Mass. Dept. of Chemistry). Contract AT(30-1)-1930. 53p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

The activities of the group devoted to research in nuclear and radiochemistry are summarized. The reported data and conclusions are subject to reanalysis before publication. Experimental mass-yield data are examined for the occurrence of fission as a mode of deexcitation in excited nuclei produced by the interaction of protons with Rh, Ag, and In targets. For Ag and In there is clear evidence for fission; with Rh, however, fission appears to be much less probable. Other experimental results include the isomeric ratios in ^{69}Zn in the reaction of ^{68}Zn with ^{14}N ions and evidence against the existence of a 2.6-hr ^{126m}I. Isomeric ratios in (α,xn) compound nuclear reactions determined previously are analyzed in terms of a statistical model which includes charged-particle competition and a limiting-spin principle. Resulting moments of inertia agree well with theoretical expectations. The extension of these calculations to consider the yields of prompt gamma rays in nuclear reactions is described. Some progress is reported in interpreting isomeric ratios in direct interactions such as (p,pn) and neutron transfer in heavy-ion induced reactions. A knock-on model appears reasonable for the (p,pn) case at 150 Mev. (auth)

22283 (ORNL-TM-1047(p.98-105)) RESEARCH MATERIALS INFORMATION CENTER. J. W. Cleland (Oak Ridge National Lab., Tenn.).

The Pure Materials Program of the Solid State Division was organized to develop the necessary techniques as required for the growth of ultra-high-purity and controlled-impurity research specimens of immediate and long range interest to ORNL, other AEC installations, and other AEC contractors. The true role of the Research Materials Information Center is to extend the present cooperation between crystal growers and crystal users, as it already exists at ORNL, to a national or international basis. Equipment has been installed that will conduct an automatic search for coded entries that have been placed on film. More than 1,000 data sheets on a wide variety of materials have already been received from about 500 individuals representing more than 60 research groups. These data sheets are coded as to material, form, dimension, orientation, impurity content, method of growth, analysis, intended use, etc. A copy of the research materials data sheet is included. (P.C.H.)

22284 (ORNL-TM-1047(p.123-6)) CALUTRON SERVICES. W. A. Bell (Oak Ridge National Lab., Tenn.).

Special projects performed through the use of calutron equipment are discussed. The most important types of special projects performed by the calutrons are described. These include: target preparation (in limited extent); high-purity isotope separation; low-activity radioisotopes separation; chemical purification by means of mass separation; and other research activities, such as studies in plasma physics involving ion beam interactions and beam stabilization and studies pertaining to ion retention by specifically oriented single crystals. (P.C.H.)

22285 (TID-21486) SOME STUDIES OF CRYSTAL ORIENTATION IN IRRADIATED POLYMERS. Annual Report, January 1, 1964–December 31, 1964. Richard S. Stein (Massachusetts Univ., Amherst. Polymer Research Inst.). Contract AT(30-1)-3003. 13p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Crosslinked samples of polyethylene were prepared by irradiation. The degree of crosslinking produced was sufficient to prevent an appreciable loss of orientation at temperatures above the melting point but did not appreciably reduce crystallinity. Crosslinking had only a slight effect on the spherulite size and morphology of the recrystallized samples. Crystallization rates were followed by the light-transmission technique, which indicated an increase in the crystallization rate due to melt orientation. Photographic light-scattering techniques were used to follow the isothermal crystallization of the oriented samples. Birefringence changes observed during isothermal crystallization did not go to negative values during slow cooling from the melt, indicating that the negative birefringent structures may crystallize from the residual amorphous material remaining from crystallization at a higher temperature. Deformed spherulitic structures were produced by crystallizing samples at elongations of less than 75%. At greater elongations, no such structures could be seen microscopically. Pole figures characterizing the crystal orientation distributions were readily obtained. (W.L.G.)

22286 (TID-21716) NUCLEAR REACTION STUDIES. Progress Report for Year Ending May 31, 1965. John M. Alexander (State Univ. of New York, Stony Brook. Dept. of Chemistry). Contract AT(30-1)-3403. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Results of studies concerning the reactions of ^{209}Bi with ^{3}He and ^{4}He are presented in which scattering of recoils in the target layer and angular resolution corrections due to finite collection area, finite target area, and beam angular definition were investigated. The experiments were conducted using various target thicknesses and collection geometries. Work toward a better understanding of the deexcitation of compound nuclei with high angular momenta is reported in which the standard spin-dependent statistical model of the decay process was programmed to yield cross sections for products of the type (X−xn) and spectra of the emitted particles and radiations. The program was applied to the reaction ^{140}Ce(^{16}O,xn)$^{156-x}$Dy. Results using O ions at 90 Mev and x = 3 to 6 agree with experimental findings. Investigations of ^{209}Bi reactions with ^{16}O were conducted to study the near-barrier production of ^{211}At and ^{210}Po, and to obtain absolute cross sections for production of α emitters at bombarding energies from threshold to 163 Mev. Another investigation was conducted to determine the respective roles of fission, fragmentation, and spallation in the production of ^{149}Tb by irradiation of ^{197}Au with 2.2-Bev protons. Data on angular distribution of ^{149}Tb products and range distribution are included. (J.R.D.)

22287 (UCRL-11948) BIO-ORGANIC CHEMISTRY ANNUAL REPORT, DECEMBER 1963 THROUGH DECEMBER 1964. (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 9, 1965. Contract W-7405-eng-48. 36p. Dep.; $2.00(cy), 1(mn) CFSTI.

Progress is reported in studies of the photosynthesis of carbon compounds; the biosynthesis of opium and tobacco alkaloids; the structure and chemistry of chloroplasts; problems in biological organization and regulation; the physical chemistry of biological systems; the optical properties of biopolymers; the fate of the radical initiator in the radiolysis of crystalline choline chloride; the origin of biohydrocarbons from a one-billion-year-old sediment; the role of cyanamide in chemical evolution; the photochemistry and radiation chemistry of thymine; biochemical and anatomical changes in the brain of rats induced by experience or environment; and the mechanism of D_2O-induced sterility in mice. Many of the studies involved the interaction of radiation with both chemical and biological systems as well as the use of tracer methods to define the nature of the interactions. A list is included of 39 publications during the period covered by this report. (C.H.)

22288 (JPRS-29183(p.1-9)) RADIOLYSIS OF POLYGLUCINE SOLUTION. S. V. Markevich, S. S. Kharamo-

nenko, P. Ts. Gorbunov, Ya. V. Stakhovskii (Stakhovskiy), A. I. Valakhanovich, and M. Ts. Bondarenko. Translated from Vestsi Akad. Navuk Belarusk, SSR, Ser. Biyal. Navuk, No. 3, 107-13(1964).

Dextran is a polysaccharide of bacterial origin that is synthesized from sucrose by a number of lactic-acid bacteria without changing the fructose. Leuconostoc mesenteroides is the bacterial strain most often used. Polyglucin, a product of incomplete acid hydrolysis of raw dextran, is used as a substitute for blood plasma. With repeated injections of polyglucin the patient may develop post-transfusion reactions. The antigenic and anaphylactic effects of polyglucin are associated with the structure of the molecule, which is dependent on the strain of bacteria, the composition of the fermentation medium, hydrolysis, and fractionation. Reaction mechanisms involved in the radiolysis of polyglucin solutions by ^{60}Co γ radiation are described. Data are included from studies on the toxic effects of polyglucin in dogs, rats, and rabbits, and the sterilization of polyglucin by exposure to γ radiation. (C.H.)

22289 TRITIATED NAPHTHALENE AS A CHEMICAL DOSIMETER FOR LOW RADIATION DOSES. G. Ahnstroem and C.-G. Rosen (Royal Univ. of Stockholm). Acta Chem. Scand., 19: 263-5(1965).

Napththalene-1-T was studied as a chemical dosimeter for low radiation doses. The yield of hydrophilic compounds produced by irradiation of a naphthalene-water solution was determined as a function of dose and naphthalene concentration. The 0.065 mm concentration yielded the lowest control value, while still being in the range where the yield is independent of the concentration of naphthalene. This solution gave a linear dose response curve from 1 to 3000 rad, and was independent of dose rate between 3 and 50,000 r/hr. The naphthalene dosimeter had a storage life of at least 14 days with retained capacity to measure doses down to 1 rad. (M.C.G.)

22290 THE STABILITY OF ANTHRACENE OIL AGAINST NUCLEAR REACTOR RADIATION AT TEMPERATURES UP TO 350°C. E. Proksch (Osterreichische Studiengesellschaft fur Atomenergie GmbH, Seibersdorf, Austria). Atomkernenergie, 10: 33-8(Jan.-Feb. 1965). (In German)

The irradiation of a VOEST anthracene oil in a nuclear reactor (about 50% of the absorbed dose by gamma radiation, 50% by fast neutrons) at temperatures between 150 and 350°C resulted in the following initial G-values for the decomposition of the anthracene oil: $G^0(-A) = 0.40$ (150-200°C); 0.41 (275°C); 0.45 (315°C); 0.57 (350°C). These values are only about 80% higher than the corresponding terphenyl G-values. Due to the lower molecular weight of anthracene oil and due to the different decomposition kinetics the percentual decomposition in the same radiation field of the anthracene oil is not higher than by 35 to 50% at most compared with terphenyl. Similar values have been found for the production of radiolytic gases. In the range of up to 40% the radiolytic decomposition of anthracene oil may be well described by a second-order rate law. The high-boiling decomposition products formed show a number-average molecular-weight of about 525 (about three times the molecular-weight of the oil used). The radiolytic gas is composed mainly of H_2 and CH_4; the H_2 fraction decreases with increasing temperature. (auth)

22291 A SIMPLE POLYETHYLENE DOSIMETER. Th. Gruenewald and G. Rumpf (Bundesforschungsanstalt fur Lebensmittelfrischhaltung, Karlsruhe, Ger.). Atompraxis, 11: 95-8(Feb. 1965). (In German)

If polyethylene is irradiated in an atmosphere containing oxygen, it increases in weight in linear proportion to the dose up to 50 Mrad. For foils with a thickness of 50 μ, this weight increase amounts to about 1% at 100 Mrad. This process runs parallel to an increase in the peroxide and saponification index, and is so easy to reproduce that it can be used in dosimetry. (auth)

22292 THE REACTIONS OF HYDROGEN SULFIDE WITH HYDRATED ELECTRONS AND FREE HYDROGEN ATOMS AND THE SOLVATION ENERGY OF ELECTRONS IN WATER. G. Meissner and A. Henglein (Hahn-Meitner-Institut fur Kernforschung, Berlin). Ber. Bunsenges. Physik. Chem., 69: 3-7(1965). (In German)

Hydrogen sulfide reacts with hydrated electrons in aqueous solutions with a bimolecular rate constant of $(1.35 \pm 0.1) \times 10^{10}$ mole^{-1} liter sec^{-1}. Per capture process $e^-_{aq} + H_2S \rightarrow H_2 + S^-$, 1.86 captures of the type $e^-_{aq} + H_2S \rightarrow H + HS^-$ take place. Free D atoms react with D_2S 7.5 times faster than with the formate anion. The rate constant of the reaction $H + H_2S \rightarrow H_2 + SH$ in aqueous solution amounts to about 1×10^9 mole^{-1} liter sec^{-1}. These results were partly obtained by pulse radiolysis, partly by studying the competition of hydrogen sulfide with nitrous oxide and sodium formate for hydrated electrons and hydrogen atoms from the radiolysis of water. While there exists an energy barrier of 2.2 ev for the reaction of the free electron with hydrogen sulfide in the gas phase, practically no activation energy is present for the reaction in aqueous solutions. The hydration energy of those electrons that can react with H_2S in water at every collision was calculated to be equal to or less than 1.4 ev by use of the hydration energy of the SH^- ion and the value of that energy barrier in the gas phase. (auth)

22293 ON THE INFLUENCE OF RARE GASES ON THE RADIATION CHEMISTRY OF ETHANE. Guenther von Buenau (Max-Planck-Institut fur Kohlenforschung, Mulheim, Ger.). Ber. Bunsenges. Physik. Chem., 69: 16-20(1965). (In German)

Gamma-radiolysis of ethane in presence of about a 25-fold excess of the inert gases argon, krypton, and xenon led to radiolysis products with G-values of the same order of magnitude as in the radiolysis of pure ethane. From these G-values it was possible to derive the sensitization efficiency of inert gases, namely η_{Ar} and $\eta_{Kr} \approx 1$, $\eta_{Xe} \approx 0.53$. The possible intervention of inert gas ions in the chemical relay mechanism for energy transfer is discussed. (auth)

22294 INTERACTION BETWEEN ACRIDINE ORANGE AND UV-IRRADIATED DNA. G. B. Zavil'gel'skii, O. F. Borisova, L. E. Minchenkova, and E. E. Minyat (Inst. of Radiation and Physicochemical Biology, Moscow). Biochemistry (USSR) (English Transl.), 29: 437-44(May-June 1964). Translated from Biokhimiya, 29: 508-17(May-June 1964).

The fluorescence and absorption characteristics of acridine orange (AO) were investigated during its reactions with irradiated DNA. By this method the nature of the structural changes induced in the DNA molecule by ultraviolet light was investigated. Unlike untreated DNA, uv irradiated DNA adsorbed AO in the form of dimers. DNA irradiated with uv light and then denatured by heat adsorbed fewer AO dimers than unirradiated DNA. With increasing doses of uv quanta, both effects became more marked. Results indicated that uv radiation induces local denaturation changes in DNA and cross linkages between the complementary strands. (auth)

22295 PRODUCTION OF ^{51}Cr OF HIGH SPECIFIC ACTIVITY. R. Draskovic, Z. Maksimovic, and S. Kozomara. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 143-53 (July 1963).

Possibilities for the production of ^{51}Cr(VI) by irradiating chromic oxide in a nuclear reactor were investigated. Hydrated and dehydrated chromic oxide were irradiated and the dependence of the yield of ^{51}Cr(VI) on the irradiation time, the water contained in chromic oxide samples, and acceptors such as $Na_2CO_3 \cdot 10\ H_2O$, $NaHCO_3$, and $(NH_4)_2S_2O_3$, was determined. In the chemical treatment of the irradiated samples the dependence of the ^{51}Cr(VI) yield was investigated as a function of the solvent, treatment time, and temperatures. (auth)

22296 MODIFICATIONS OF MACROMOLECULES BY IRRADIATION. J.-R. Puig. Bull. Inform. A.T.E.N. (Assoc. Tech. Energie Nucl.), No. 51, Suppl., 3-7(Jan.-Feb. 1965). (In French)

The principal chemical modifications that can take place

during irradiation can be placed in two categories. The first is pure radiolysis that is shown, according to the nature of the polymer, by reticulations or by degradations. The second is the radiochemical syntheses obtained when the polymer is placed in the presence of a reacting medium. Each of these is discussed. (J.S.R.)

22297 CHARGE TRANSFER IN THE RADIOLYSIS OF DILUTE SOLUTIONS OF HYDROCARBONS IN KRYPTON MATRICES AT 77°K. J. A. Stone (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 43: 809-19(Apr. 1965). (AECL-2161)

The radiolysis of dilute solutions (0.3 to 10 electron %) of saturated hydrocarbons in krypton matrices at 77°K resulted in the production of much more hydrogen than that obtained in the absence of krypton. This enhanced hydrogen yield was independent of hydrocarbon concentration over the range studied. The cyclohexane–krypton system was studied in detail. The energy transferred from the krypton to the cyclohexane resulted in a large first-order yield of hydrogen with a corresponding large yield of cyclohexene. Cyclohexane-d_{12} irradiated at the same concentration in a krypton matrix had the same product yields. However, when mixtures of cyclohexane and cyclohexane-d_{12} were irradiated in a krypton matrix the hydrogen evolved had a high H_2 content, which must be the result of an isotope effect in the energy transfer process. This isotope effect and the enhancement of product yields is consistent with a charge transfer mechanism. (auth)

22298 AN ELECTRON SPIN RESONANCE STUDY OF TRAPPED ELECTRONS FORMED AT 77.5°K BY GAMMA IRRADIATION OF AN ORGANIC GLASS. D. R. Smith and J. J. Pieroni (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 43: 876-87(Apr. 1965). (AECL-2165)

2-Methyltetrahydrofuran (MTHF) traps electrons and free radicals or radical-ions when irradiated with ^{60}Co gamma rays at 77.5°K. The ESR (electron spin resonance) difference spectrum technique was used to determine the microwave saturation properties and line shape parameters of the absorption due to "trapped" electrons. These measurements supported the postulate that physically trapped electrons are present and indicated that trapped electrons and free radicals or radical-ions exist in local concentrations that are considerably greater than their average concentration in the sample. It was concluded that they are trapped in clusters. A study of the thermal decay of the trapped electrons supported the cluster model. (auth)

22299 THE RADIATION-INDUCED DECOMPOSITION OF N-BENZYLDIMETHYLAMINE AND BENZYLTRIMETHYLAMMONIUM HYDROXIDE IN AQUEOUS SOLUTION. P. G. Clay and A. Kabi (Imperial Coll. of Science and Tech., London). Chem. Ind. (London), No. 5, 226-7 (Jan. 30, 1965).

The radiation chemistry of dilute (10^{-3} M) aqueous solutions of two model compounds, namely N-benzyldimethylamine and benzyltrimethylammonium hydroxide, was studied. All irradiations were carried out using ^{60}Co γ radiation; a dose rate of 0.50×10^{20} ev/l/min was employed and maximum doses $\sim 30 \times 10^{20}$ ev/l/min. A major radioinduced reaction observed in both cases was the cleavage of the benzyl-amino group bond resulting in the formation of trimethylamine from benzyltrimethylammonium hydroxide and of dimethylamine from benzyldimethylamine. Other products were also formed, thus benzaldehyde and salicylaldehyde were detected in irradiated oxygenated solutions of benzyltrimethylammonium hydroxide. Factors affecting the elimination of the functional group were investigated. The deamination reactions were most important at pH values greater than 4. At pH 1 the yields of dimethylamine from benzyldimethylamine and of trimethylamine from benzyltrimethylammonium hydroxide were small. Deamination yields were higher in evaluated solution than in oxygenated solution. The effects of various solutes on the rates of formation of dimethylamine and trimethylamine were studied, and the G values for the formation of trimethylamine from benzyltrimethylammonium hydroxide solutions (10^{-3} M) are tabulated. G(trimethylamine) was reduced by the addition of N_2O, NO_3^- ions, and oxygen prior to irradiation. These solutes also brought about reductions in yield of dimethylamine in irradiated solutions of benzyldimethylamine (10^{-3} M). Oxygen, N_2O, and nitrate ions were effective in protecting benzyldimethylamine against decomposition but ethanol was ineffective. Possible mechanisms are outlined. (TCO)

22300 RADIATION CHEMISTRY. A. G. Maddock (Univ. of Cambridge, Eng.). Chem. Ind. (London), No. 52, 2123-5(Dec. 26, 1964).

A historical resume and discussion of new developments are presented, including: early use of radon; free radical production; radiolysis of aqueous systems; radiolytic mechanisms; chemical effects of radiation; development of applied radiation chemistry; radiation polymerization; and industrial applications. Russian literature in the field of radiolysis is briefly discussed. (TCO)

22301 CHEMICAL-TECHNOLOGICAL APPLICATIONS OF RADIATION CHEMISTRY. W. A. Cramer and J. P. W. Houtman. Chem. Weekblad, 60: 549-56(1964).

A description is given of beta- and gamma-radiation sources and the interaction between radiation and matter. Several industrial applications and the economic aspects, such as polymerization of ethylene, are considered. (RCN)

22302 SPECTRAL ANALYSIS OF THE THERMOLUMINESCENCE OF MOLECULAR SOLIDS IRRADIATED BY γ RAYS AT 77°K. CASE OF DIPHENYL. Jacques Bullot and Fernand Kieffer (Universite de Paris, Orsay, France). Compt. Rend., 260: 1171-3(Jan. 25, 1965). (In French)

A method for spectral analysis of thermoluminescence by means of a monochromator was applied to the case of biphenyl solutions in ethanol and cyclohexane. The spectrum obtained was identified as the phosphorescence spectrum of biphenyl. (tr-auth)

22303 THERMOELECTRON IRRADIATION OF POLYETHYLENE FILMS. Takao Sakai and Yotsuo Toriyama (Musashi Inst. of Tech., Japan). Denki Gakkai Zasshi, 84: 1600-7(Oct. 1964). (In Japanese)

In order to elucidate the mechanism of deterioration of dielectric materials by corona discharge, high density polyethylene films were irradiated with electron beams of 200 to 600 ev. The degree of crystallinity of the polyethylene was 93% and the thickness of the films was 0.05 mm. The energy of the electron beams was determined by the electromagnetic deflection technique to avoid the influence of space charge. Irradiations were done in N_2 or in air of about 10^{-3} mm Hg.; the small amount of O_2 as an impurity was not completely eliminated in the case of N_2. The total amounts of irradiation given were 10^{-1} to 10^{-3} coulomb/mm^2. The surface resistivities of unirradiated films and films irradiated at 1.7×10^{-2} coulomb/mm^2 in N_2, 1×10^{-1} coulomb/mm^2 in air, and 5.6×10^{-2} coulomb/mm^2 in air were determined. The activation energies calculated from the temperature dependency of the resistivities were 4.73, 4.67, 4.51, and 4.51 ev, respectively. Infrared spectra of the unirradiated and irradiated films are given, in which the formation of carbonyl groups by surface oxidation is shown even in the case of irradiations in N_2. Electron-microscopic photographs, showing the changes of surface state or crack formation are also given. (auth)

22304 INVESTIGATION OF EPR SPECTRUMS OF RADIOACTIVE AND IRRADIATED SPECIMENS OF CALCIUM, STRONTIUM, AND BARIUM SULFATES. Vikt. I. Spitsyn, V. V. Gromov, and L. G. Karaseva (Inst. of Physics and Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 159: 178-81(Nov. 1, 1964). (In Russian)

Transformations occurring in the crystal lattices of alkaline earth sulfates following internal irradiation with ^{35}S contained in the molecule were compared, by an electron paramagnetic resonance method, with those resulting from external irradiation with a gamma radiation from a ^{60}Co source. The temperature was varied from –197 to

300°C. The results showed that the nature of some of the paramagnetic centers is the same for the two cases. The spectra of the gamma-irradiated samples of $CaSO_4 \cdot 2H_2O$, $SrSO_4$, and $BaSO_4$, in comparison with the radioactive samples, showed a large number of paramagnetic centers, which differed in nature. The absorbed dose in the first case was greater than in the second by two orders of magnitude. A comparison of the yield of paramagnetic centers in the cases of the three substances indicated that $CaSO_4 \cdot 2H_2O$ has the greatest radiation stability and $SrSO_4$ the least. This was the same order in which the compounds may be arranged according to their heats of formation: $CaSO_4 \cdot 2H_2O$, 483.06; $BaSO_4$, 350.2; and $SrSO_4$, 345.3 kcal/mole. (TTT)

22305 COLORING AND LUMINESCENCE OF GAMMA RAY-IRRADIATED SYNTHETIC RUBIES. L. F. Vereschagin, S. V. Starodubtsev, and M. S. Yunusov. Dokl. Akad. SSSR, 195: 300-2(Nov. 11, 1964). (In Russian)

Crystals of light-rose synthetic ruby containing about 0.2 to 0.4% Cr_2O_3 were irradiated with γ rays at a dose rate of 350 r/sec and a source temperature of 34°C. The absorption spectrum of ordinary and extraordinary rays was measured by a system that included a monochromator, a light polarizer, and that photomultiplier. It was found that at a dose of 10^3 r the absorption spectrum had already undergone a noticeable change. With an increase in dose, ruby density increased within the green and violet regions of the spectrum. At 10^3 r the greatest density change was in the red region, which remained virtually unchanged at higher doses. Pleochroism appeared in the 420 to 530-mμ region and increased with each increase in dose. At doses on the order of 10^6 r, there was a noticeable color saturation. With irradiation, the spectrum shifted toward the short-wave region. Investigations of thermoluminescence due to irradiation of specimens annealed at a temperature rate of 4 ± 0.3°C/min, showed that within the temperature range of 20 to 500°C, a wide luminescence maximum occurs at 300°C. The specimens thus annealed almost completely lost the color acquired through radiation. Heating of an irradiated specimen to 250°C followed by slow cooling had no effect on the absorption spectrum, but its illumination with ultraviolet rays from a mercury vapor lamp resulted in a more intense luminescence than that of nonirradiated specimens, in the fading of absorption radiation bands, and in the loss of thermoluminescence. Qualitative studies were made of the paramagnetic resonance spectrum in irradiated specimens. A parallel spectrum was investigated at a frequency of 9368 Mc. It was found that at doses of several thousand r, the number of absorption centers noticeably increases, and that at the points of maximum slope the lines become wider. It was also found that the line due to transition $\frac{1}{2} \rightleftharpoons -\frac{1}{2}$ is more sensitive to irradiation than the line due to transition $-\frac{1}{2} \rightleftharpoons \frac{1}{2}$. (CFSTI)

22306 ON THE RADIATION-INDUCED POLYMERIZATION. Yoneho Tabata (Tokyo Univ.). Enka Biniru, 4: No. 10, 20-5(Oct. 1964). (In Japanese)

Studies of radioinduced solid-state polymerization of acrylamide are described. The pressure effect and the mechanism of the solid-state polymerization of acrylamide are discussed. Both two-phase mechanism, where the defect of lattice plays an important part, and a mechanism by which polymerization proceeds along the lattice of monomer were previously proposed. It is suggested that the lattice control predominates in the earlier stage and the two phase mechanism in the later stage. Pressure effects obtained support this. (NSA of Japan)

22307 GRAFT-COPOLYMERIZATION OF STYRENE ON POLYVINYL CHLORIDE BY IONIZING RADIATION. Toshiaki Takamatsu (Inst. of Physical and Chemistry Research, Tokyo). Enka Biniru, 4: No. 11, 18-25(Nov. 1964). (In Japanese)

Films of polybinyl chloride (PVC) were irradiated in liquid styrene (St) and in styrene vapor with ^{60}Co γ rays, and the graft-copolymerization studied. The dose rates (I) were 4.2×10^2 to 1.7×10^5 rad/hr. The relation between the grafting density (mole/l) and irradiation time was linear for several hours of induction. The grafting velocity (Rp) was proportional to $I^{1/2}$ in the case of liquid-immersion type grafting; it was proportional to $I^{1/2}$ at $I < 4.8 \times 10^3$ rad/hr and was constant at $I > 2 \times 10^4$ rad/hr in the case of vapor-phase irradiation. The PVC films, which absorbed St monomer in different concentrations, were irradiated for 1 to 3 hours at 4.8×10^4 rad/hr, and it was found that the amount of the graft-copolymer was the largest at monomer concentrations of 3 to 4 mole/l. These results were treated kinetically, and the apparent values of Rp, kp^2/kt, and kt, where kp is the propagation constant and kt is the chain terminating constant, at the initial stages, are given for the different absorbed monomer concentrations. It was found that kt increases rapidly as the monomer concentration increases over 3.5 mole/l. The higher grafting efficiency in the vapor-phase irradiation than in the liquid phase irradiation may be explained by considering the effect of absorbed monomer concentration on kt. The lower grafting velocity at higher absorbed monomer concentration may be due to the higher rate of free radical recombination, resulting from the larger molecular movement of the polymer chain segments, which is a result of a lowering of the secondary transition point by the plasticizing effect of the absorbed St monomer. (NSA of Japan)

22308 SPIN DIFFUSION AND NUCLEAR RELAXATION IN IRRADIATED POLYMERS. L. L. Buishvili and A. V. Kessenikh (Inst. of Chemical Physics, Moscow). Fiz. Tverd. Tela, 6: 3016-19(1964).

The case when nuclear spin diffusion time is shorter than the time of direct relaxation of the nuclei closest to the local paramagnetic center was considered. In such a case it is possible to introduce a single nuclear spin temperature and consequently assume an equal value for the nuclear polarization at each point, not necessarily equal to the equilibrium value. In this case, starting from the relaxation equation at an arbitrary point, simple calculations led to the same results as the standard solution for the nuclear spin diffusion equation. A comparison of the theoretical calculation for a local paramagnetic center delocalized along a linear polymer chain (such as polyethylene) led to satisfactory agreement. (CFSTI)

22309 MEASUREMENT OF THE ENERGY STORED IN LiF CRYSTALS AFTER IONIZING IRRADIATION AT ROOM TEMPERATURE. E. K. Zavadovskaya and A. V. Kuz'mina (Tomsk Polytechnic Inst., USSR). Fiz. Tverd. Tela, 6: 3348-50(1964).

The energy stored in LiF crystals during x-ray and gamma irradiation at room temperature was measured. Two identical samples ($7 \times 7 \times 12$ mm³) were cleaved from LiF crystals and annealed. One sample was irradiated, and then both were attached to thermocouples, in an aluminum calorimeter, and heated in an oven at the rate of 2°C per minute. For gamma doses of 1.52, 2.4, and 3.54×10^5 r, the energy stored was found to be 240, 300, and 360 cal/g, respectively. These values were two orders of magnitude greater than those previously obtained under the same experimental conditions for NaCl and KCl. With a 3.5×10^5 r dose, the concentration of F-centers was found to be 1.3×10^{19} or one order of magnitude greater than that of NaCl and KCl bombarded with the same dose. The unusually large values for stored energy were attributed to the accumulation of large amounts of colloidal Li. In addition to the thermal effect accompanying the recombination of defects, a thermal effect also arose from a change in specific heat resulting from the accumulation of colloidal metal. (CFSTI)

22310 DETACHMENT AND MOTION OF DISLOCATIONS IN RADIATION-HARDENED LITHIUM FLUORIDE CRYSTALS. I. G. Berzina, A. A. Blistanov, and L. G. Tsinzerling. Fiz. Tverd. Tela, 6: 3402-8(1964).

To identify the types of defects responsible for radiation hardening of lithium fluoride crystals, the influence of neutron irradiation of LiF single crystals on the immobilization and mobility of dislocations following irradiation, when a concentrated load is applied was investigated. The single crystals were grown under factory

conditions by the Kriopoulos method, and had an initial dislocation density of about 10^{14} cm^{-2}. The samples were in the form of rectangular bars measuring 10 × 10 × 1 mm for observing absorption spectra and 20 × 10 × 5 mm bars for the measurement of internal friction. Three samples in each batch were exposed in a reactor to 1.00 to 1.25 × 10^{11} n/cm^2 · sec, of which about 10% were fast neutrons and the rest thermal neutrons. All mechanical and optical measurements were made several hours after stopping the irradiation. Mechanical pressure was applied by the diamond pyramid of the PNT-3 instrument under different loads. The dislocation distribution was determined by etching and microscopic examination. Absorption spectra were taken. The internal friction was measured by the compound vibrator method at 130 kc. The measurements yielded the variation in the length of the prong of the etch-figure star with load for different radiation doses. The results indicated that irradiation caused an increased concentration of point defects, chiefly in the vicinity of the dislocations. (A.T.D. Press)

22311 USE OF ACCELERATORS IN HIGH MOLECULAR CHEMISTRY. T. Shchematsu. Genshiryoku Kogyo, 9: No. 6, 15-19(1963). (In Japanese)

Applications of accelerators in radiation chemistry are discussed. Most of the work was done with currents of 100 μa. In Japan work was done on an industrial scale to obtain crosslinking by irradiation of polyethylene. In operation of the accelerator, it is first necessary to consider the grams of material processed per hour. If P is the accelerator power (kv), G the magnitude of the reaction taking place on absorption of each 100 ev, M the molecular weight of the substance formed, and f the coefficients of efficiency, then y = 0.373 GfMP (g/hr). From this it is seen that to increase the amount of material processed P, G, and f must be increased. Higher voltage is shown to be more economical than higher currents and can be easily achieved. The voltage must be selected according to what is needed in various chemical reactions. For example, for polyethylene and similar films, accelerators with low energy and high power are better; for reacting substances, accelerators with high voltages are better. For gaseous materials, low voltages are recommended. In the high-molecular chemical industry, when electron accelerators are used the reaction rate depends on the dose. For reactions of a polyester resin the relation between reaction rate and dose is 0.94 with a dose rate of 10^5 r/hr (for ^{60}Co gamma radiation) and 0.5 with a dose rate of 10^9 r/hr (electron current). (IIC-MG)

22312 PRODUCTION OF CARRIER-FREE MANGANESE-54. K. S. Bhatki and A. T. Rane (Tata Inst. of Fundamental Research, Bombay). Indian J. Pure Appl. Phys., 3: 133-4(Mar. 1965).

A procedure is described for preparing carrier-free ^{54}Mn from neutron irradiated iron. Pyridine was employed to precipitate ferric ions as the hydrated oxide while ^{54}Mn remained in solution. Even the reagent quality iron wire gave ^{54}Mn contaminated with ^{60}Co and it was possible to get rid of this contamination using iron wire that was purified twice. (auth)

22313 INVESTIGATION OF ENERGY MIGRATION IN RECOMBINATION LUMINESCENCE OF POLYACTIVATED ALKALI-HALIDE PHOSPHORS. A. Kh. Khalilov. Izv. Akad. Nauk Azerb. SSR, Ser. Fix. Tekhn. i Mat. Nauk, No. 3, 91-8(1964). (In Russian)

A study was made of the spectral composition of thermoluminescence, x-ray luminescence, phosphorescence, and optical bursts from several poly-activated single crystals of NaCl and KCl phosphors. The purpose was to determine the laws governing the migration of the electron and hole recombination energy to the luminescence centers of luminors that contain, in addition to the luminescence centers of non-activator origin, also several luminescence centers due to activating ions. The activating elements were Pb, Ag, Cu, and Tl, with different molar concentrations. The tests showed that luminors with single and double activators have x-ray luminescence and phosphorescence spectra with bands of non-activator origin as well as bands due to more complicated centers produced by the activator. The peaks of the different spectra were identified and differences between substances identified. No recombination glow of the Tl^+ ions was observed in the thermoluminescence spectra of two-activator phosphors in the interval from −160 to −40°C, although intense luminescence bands were produced by Ag_2^+ and Cu^+. This was attributed to the selectivity of the recombination energy transferred to the different glow centers. At −22 to 20°C, however, a pronounced recombination energy transfer to the Tl^+ centers was observed. At temperatures above room temperature the phosphorescence and x-ray luminescence spectra began to deviate strongly from the thermoluminescence spectra. The differences between the spectra are discussed. (CFSTI)

22314 CATION INTERACTIONS OF TRAPPED ELECTRONS IN IRRADIATED ALKALINE ICE. Larry Kevan (Univ. of Chicago). J. Am. Chem. Soc., 87: 1481-3(Apr. 5, 1965).

Line-width studies were carried out on electron spin resonance spectra of trapped electrons in γ-irradiated alkaline ices of H_2O and D_2O as a function of the alkali cation. Contributions to the line width from both alkali cation and proton interactions were demonstrated and analyzed quantitatively. Small anisotropic contributions may also be present. The cation interaction showed that the spin density of the trapped electron is distributed over at least a 3 to 4-Å radius from the trapping center. (auth)

22315 FORMATION OF MONOCHLOROCARBENE BY THE GAS-PHASE DECOMPOSITION OF DIHALOMETHANE MOLECULES EXCITED THROUGH RECOIL TRITIUM SUBSTITUTION REACTIONS. Yi-Noo Tang and F. S. Rowland (Univ. of Kansas, Lawrence and Univ. of California, Irvine). J. Am. Chem. Soc., 87: 1625-6(Apr. 5, 1965).

Monchlorocarbene was formed in the gas phase by dehydrohalogenation of highly excited dihalomethane molecules. The dihalomethane molecules were excited by hot atom substitution of tritium for hydrogen, forming $CHTClX^*$ from CH_2ClX. The monochlorocarbene thus created is CTCl, and is detected by the radioactivity of the cyclopropyl-t chloride formed in the presence of ethylene. (M.C.G.)

22316 RADIOLYSIS OF DIETHYL ETHER. I. LIQUID PHASE. Mark K. M. Ng and Gordon R. Freeman (Univ. of Alberta, Edmonton). J. Am. Chem. Soc., 87: 1635-9 (Apr. 20, 1965).

The G values of the major products of the γ radiolysis of liquid diethyl ether at 25°C and a dose of 10^{20} ev/g are: hydrogen, 3.4; 2,3-diethoxybutane, 2.6; ethanol, 2.1; ethane, 1.3; ethylene, 0.8; ethyl vinyl ether, 1.1 (at 8 × 10^{20} ev/g); ethyl sec-butyl ether, 0.7; and $G(-C_2H_5OC_2H_5) = 11.3$. The yields of most of the products were independent of dose over the range studied. However, $G(C_2H_4)$ decreased from 1.1 at 8 × 10^{18} ev/g to 0.6 at 3.9 × 10^{20} ev/g. The value of $G(H_2)$ decreased from an extrapolated value of 3.7 at zero dose to a steady value of 3.4 at doses greater than 4 × 10^{19} ev/g. Ethyl vinyl ether, 1,3-pentadiene, and benzene inhibited the formation of all of the products except CO($G = 0.07$). The reaction mechanism is discussed. The approximate yields of three kinetically distinguishable sources of hydrogen were $G(e^-_{solv}$, free ion) = 0.3, G(scavengeable H_2) = 1.4, and G(unscavengeable H_2) = 2.0. The relative probabilities, per bond, of cleavage of the various types of bond are C−O ($G = 1.6$) ≫ C−H ($G = 0.34$) > C−C ($G = 0.28$). The value of the ratio of the steady-state concentration of $CH_3CHOC_2H_5$ radicals to that of $CH_2CH_2OC_2H_5$ radicals in liquid ether during radiolysis was about 40 to 1. (auth)

22317 RADIOLYSIS OF DIETHYL ETHER. II. DEUTERIUM-SUBSTITUTED ETHERS IN THE GAS AND LIQUID PHASES. Mark K. M. Ng and Gordon R. Freeman (Univ. of Alberta, Edmonton). J. Am. Chem. Soc., 87: 1639-43 (Apr. 20, 1965).

The G values of the major products of the γ radiolysis of diethyl ether vapor at 25°C and a dose of 3 × 10^{20} ev/g are:

hydrogen, 6.4; 2,3-diethoxybutane, 2.4; ethylene, 2.1; acetaldehyde, 1.4; methane, 1.3; ethyl isopropyl ether, 1.0; formaldehyde, 0.9; ethyl sec-butyl ether, 0.8; ethanol, 0.7; and $G(-C_2H_5OC_2H_5) = 11.2$ based on the carbon in the measured products; and G(excess H_2 in products) = 1.7. The yields of acetaldehyde and ethyl vinyl ether ($G = 0.4$ at 19×10^{20} ev/g) decreased with increasing dose. The value of G(−ether) in the vapor phase was nearly the same as that in the liquid phase, although the product distribution was quite different in the two phases. Ether molecules, on the average, broke into smaller fragments in the gas than in the liquid phase radiolysis. For the reactions $R + M \rightarrow RH + R'$, ($k_a$), and $R + R \rightarrow R_2$, K_c, k_a/k_c was smaller in the vapor than in the liquid phase. Comparison of the product yields from the radiolysis of $(C_2H_5)_2O$, $CD_3CH_2)_2O$, $(CH_3CD_2)_2O$, and $(C_2D_5)_2O$ showed that α-C−H bond cleavage was most important in hydrogen and methane formation, and β-C−H cleavage was most important in ethylene formation although both types of cleavage made significant contributions to the formation of all three products. (auth)

22318 ENERGY TRANSFER AND RADICAL SCAVENGING IN THE RADIOLYSIS OF SOLUTIONS OF p-BENZOQUINONE IN CYCLOHEXANE. F. C. Goodspeed and J. G. Burr (North American Aviation Science Center, Thousand Oaks, Calif.). J. Am. Chem. Soc., 87: 1643-7 (Apr. 20, 1965).

The γ radiolysis of 40 mm of benzoquinone in cyclohexane solutions gave the following products (the numbers are yields in molecules/100 ev absorbed in the whole solution): cyclohexene, 1.0; bicyclohexyl, 0.15; hydrogen, 3.1; monocyclohexylquinone, 4.4; and hydroquinone (mostly as the quinhydrone), 3.1. Quinone is consumed with a G value of 10.8; quinone-containing products are formed with a G value of 10.6. Photolysis of saturated quinone solutions (40 mm) gave cyclohexylquinone and hydroquinone (as the quinhydrone); no cyclohexene or bicyclohexyl could be detected. The quinone recovered from a γ-irradiated solution of quinone in tritiated cyclohexane did not contain any radioactivity, indicating that quinone does not scavenge hydrogen atoms in this system under these conditions. The data were interpreted in terms of a set of processes, which includes the scavenging of cyclohexyl radicals with a yield of 3.4 molecules/100 ev absorbed, deactivation of activated cyclohexane molecules by quinone with a yield of 2.3 (followed by reaction of about 50% of the activated quinone molecules with cyclohexane), and a "molecular" process for cyclohexene and hydrogen with a yield of 1.0. (auth)

22319 ION-MOLECULE REACTIONS BETWEEN RARE GAS IONS AND METHANE. G. R. Hertel and W. S. Koski (Johns Hopkins Univ., Baltimore). J. Am. Chem. Soc., 87: 1686-91(Apr. 20, 1965). (TID-21657)

The reactions of He^+, Ne^+, Ar^+, Kr^+, and Xe^+ with methane were studied over an energy range of 2 to 200 ev. The yields of the fragment ions of methane corresponded well to the findings of other investigators working at both thermal and higher energies and were found to vary only slightly with the energy of the incident ions. The relative cross sections showed some deviations from the predictions of the theory of ion−molecule reactions. Exothermic reactions showed an initially decreasing cross section as the kinetic energy of the encounter increased. At higher energies the cross sections leveled off and tended to increase: $E^{-\frac{1}{2}}$ energy dependence was followed only in the $He^+ - CH_4$ reactions at energies below 10 ev. Endothermic reaction cross sections were very low and showed slight increases with energy over the entire range studied. (auth)

22320 EFFECTS OF γ IRRADIATION ON THE DIVALENT HOLMIUM CONCENTRATION IN CaF_2. E. S. Sabisky (Radio Corp. of America, Princeton, N. J.). J. Appl. Phys., 36: 1788-9(May 1965).

Experimental results on the absolute number of holmium ions in the host of CaF_2 which are converted to the divalent state as a function of γ-irradiation dosage and rare-earth concentration are presented. The measurements amounted to a comparison between the divalent holmium paramagnetic line and the resonance line of trivalent chromium in Al_2O_3. (C.E.S.)

22321 CROSSLINKING OF CIS-POLYBUTADIENE BY Co^{60} γ-RAYS. Bogdan Jankowski and Jerzy Kroh (Inst. of the Rubber Industry, Warsaw and Technical Univ., Lodz, Poland). J. Appl. Polymer Sci., 9: 1363-6(Apr. 1965).

The radioinduced vulcanization of cis-polybutadiene (Europrene Cis, 92% cis-configuration) was investigated. The crosslinking density of irradiated rubber was determined by two methods, equilibrium swelling and equilibrium compression modulus. The inhibition and acceleration of radioinduced crosslinking by addition of sulfur, Thiurame, Elastopar, Arubrene, paraffin oil, or barium sulfate was studied. The chemical resistance of radiation vulcanizates to 10% nitric acid was determined. (auth)

22322 RADIATION PROTECTION OF POLYETHYLENE. J. B. Gardner and B. G. Harper (Dow Chemical Co., Freeport, Tex.). J. Appl. Polymer Sci., 9: 1585-91(Apr. 1965).

It is shown that polyethylene can be made more stable to radiation by either mixing aromatic compounds with the polyethylene or by grafting styrene onto the polyethylene. In either case, the polymer has greater radiation resistance than predicted from the law of averages. Aromatic compounds having the greatest resonance energy protected the polymer to the greatest extent. In mixtures, polystyrene gave the least protection, and naphthalene, anthracene, and phenanthrene gave the greatest protection. Polyethylene grafted with styrene had better radiation resistance than a polyethylene−polystyrene mixture. The $G(H_2)$ was calculated for each sample, and curves are presented illustrating the effect. (auth)

22323 ELECTRON SPIN RESONANCE OF $R\dot{C}HCOR'$ RADICALS IN X-IRRADIATED KETONE−UREA INCLUSION COMPOUNDS. O. Hayes Griffith (California Inst. of Tech., Pasadena). J. Chem. Phys., 42: 2644-50(Apr. 15, 1965).

Single crystals of six inclusion compounds formed between aliphatic ketones and urea were x irradiated at room temperature, and the free radicals produced were investigated by electron spin resonance. The six ketones investigated were 2-nonanone, 6-undecanone, 3-tetradecanone, 2-undecanone, 2-dodecanone, and 3-undecanone. The long-lived free radicals observed in all of these compounds ($RCH_2\dot{C}HCOR'$) were formed by the removal of one α proton from the parent ketone. The unpaired spin density in the 2p orbital adjacent to the carbonyl group were 0.81 ± 0.08. A contour plot of the spin density as a function of the molecular orbital parameters is given. In qualitative agreement with the ESR results, the molecular orbital methods predict the position of maximum spin density to be adjacent to the carbonyl group. (auth)

22324 ELECTRON SPIN RESONANCE AND ELECTRONIC STRUCTURE OF THE $R\dot{C}HOR'$ ETHER RADICALS. O. Hayes Griffith (California Inst. of Tech., Pasadena). J. Chem. Phys., 42: 2651-7(Apr. 15, 1965).

Single crystals of inclusion compounds formed between urea and a series of aliphatic ethers were x irradiated and studied by electron spin resonance. The stable, x-ray-produced free radicals were all of the general type $R\dot{C}HOR'$. The approximate value for the spin density on the carbon atom was 0.70 ± 0.10. The unpaired spin distribution is discussed in terms of the Hückel and approximate configuration interaction π-electron molecular orbital models and the valence bond method. The theoretical spin distributions were found to be in qualitative agreement with the experimental spin distribution. (auth)

22325 NATURE OF THE CHEMICAL REACTIVITY OF RADIOBROMINE ATOMS PRODUCED BY ISOMERIC TRANSITION. A. R. Kazanjian and W. F. Libby (Univ. of California, Los Angeles). J. Chem. Phys., 42: 2778-83(Apr. 15, 1965).

The hot-atom chemistry of n-propyl bromide was examined further. By comparing the differences and similarities

of the (n,γ) and isomeric transition processes, an over-all theory was evolved, which accounts for the identical results produced by both nuclear processes in the solid liquid alkyl halides. The charge developed by the Auger process following internal conversion causes the molecule to explode and gives a neutral recoiling atom, which then reacts as the (n, γ) atoms. The neutralization after rupture is rapid in the solid and liquid. In the gas this is not so and it was possible to demonstrate experimentally a difference between the retentions in the gas phase. (auth)

22326 ELECTRON SPIN RESONANCE IN GAMMA-IRRADIATED SINGLE CRYSTALS OF HYDROXYLATED ORGANIC COMPOUNDS. M. Jagannadha Rao and Roy S. Anderson (Clark Univ., Worcester, Mass.). J. Chem. Phys., 42: 2899-2904(Apr. 15, 1965).

Free radicals produced by gamma irradiation in the single crystals of four hydroxylated organic compounds, monoammonium malate, monoammonium malate monohydrate, ammonium tartrate, and potassium tartrate, were studied using the methods of electron spin resonance. In all four molecules, stably trapped radicals were found to be the result of the splitting of a C–H bond adjacent to both the hydroxyl and carboxyl groups. The isotropic parts of the hyperfine couplings of the two methylene protons in monoammonium malate were 8.9 and 34.3 G. These values in the monohydrate were 14.7 and 34.1 G. The isotropic part of the hydroxyl proton hyperfine coupling in the monohydrate was 2.3 G. Strong spin-flip transitions, giving rise to satellite lines having an intensity up to 40% of the main lines for certain orientations of the crystal in the magnetic field, were observed in monoammonium malate and its monohydrate. The proton responsible for these spin-flip transitions was found to be the hydroxyl proton. The isotropic part of the C–H proton hyperfine coupling in both ammonium and potassium tartrates was 2.1 G. (auth)

22327 STANDARD ELECTRODE POTENTIAL OF THE OH^- ION. CORRELATION WITH ABSORPTION SPECTRUM AND ENERGY OF SOLVATION. Gabriel Stein (Demokritos Nuclear Research Center, Athens). J. Chem. Phys., 42: 2986(Apr. 15, 1965).

In aqueous solutions, irradiated with ionizing radiation, OH radicals are produced from the water. Standard electrode potentials of these ions were determined to be −2.1v at pH = 0 and −1.2v at pH = 14. The heat of solution for these OH ions was calculated to be 107 kcal/mole. (M.C.G.)

22328 THERMOELECTRICITY IN IRRADIATED DIELECTRICS. I. SOME GENERAL FEATURES. F. C. Hardtke (Argonne National Lab., Ill.). J. Chem. Phys., 42: 3000-9(May 1, 1965).

A transitory charge displacement was observed in gamma-irradiated solid dielectrics when the 3.2-mm-thick samples were subsequently heated in temperature gradients of 5 to 40 °C/mm. The charge displaced was found to be directly proportional to the temperature gradient and, below a megaroentgen, to the radiation exposure. With further exposure it approached a maximum of a few nanocoulombs per square centimeter. Electric fields above 100 v/mm applied to the sample during heating produced only slight changes in the magnitude of the thermoelectric discharge. A marked reduction in the discharge magnitude was observed in samples that were shielded from the radiation source by metal plates approximately 0.1 g/cm² thick. This suggested that the phenomenon may arise from the thermal release of trapped electrons, which entered the sample as Compton recoils. (auth)

22329 PHOTOCHEMICAL CHARGE-TRANSFER REACTIONS IN FROZEN AQUEOUS SYSTEMS. I. ELECTRON TRANSFER FROM THE SOLUTE TO THE MATRIX. P. N. Moorthy and J. J. Weiss (Univ. of Newcastle upon Tyne, Eng.). J. Chem. Phys., 42: 3121-7(May 1, 1965).

Hydrogen-atom ESR signals were detected at 77°K in ultraviolet-irradiated frozen acid solutions when the latter contained solutes such as I^- and Fe^{2+}, which are characterized by charge-transfer spectra in the ultraviolet. The quantum yield of hydrogen-atom formation was studied as a function of the solute concentration and of the nature and concentration of the acid present in the matrix. The results can be explained on the assumption that ultraviolet irradiation leads to a charge transfer, giving in the first instance an excited state in which the electron is transferred, to a greater or lesser extent, to the hydration shell where it is bound in the field of the oriented water molecules around the ion. The electron in the excited state can either revert to the ground state or may react with electron acceptors present in the matrix, where their reaction with, e.g., acids leads to the formation of H atoms. It was found that the excited ion can apparently also be deactivated by interaction with another like ion in the ground state. This was suggested by the observation that with increasing concentration of the light-absorbing ions the H-atom yield decreases. (auth)

22330 PHOTOCHEMICAL CHARGE-TRANSFER REACTIONS IN FROZEN AQUEOUS SYSTEMS. II. FORMATION AND TRAPPING OF HOLES. P. N. Moorthy and J. J. Weiss (Univ. of Newcastle upon Tyne, Eng.). J. Chem. Phys., 42: 3127-31(May 1, 1965).

Ultraviolet irradiation of frozen aqueous solutions of ceric ions was shown to lead to an electron transfer from the solvent molecules in the hydration shell to the ceric ion. The resulting "hole" in the matrix was trapped and exhibited a characteristic electron spin resonance (ESR) spectrum. The quantum yield for the trapping of the holes was investigated as a function of the concentration of the solute and for different ice matrices. ESR spectra of trapped holes were also observed on optical bleaching of the color centers produced by γ irradiation of frozen aqueous matrices containing H_2SO_4, H_3PO_4, or $HClO_4$ at 77°K. Subsequent annealing of these colorless matrices at 120°K restored the original color centers, whereas the trapped holes disappear. These processes can be repeated through many cycles, practically without diminution of the color-center-hole concentrations. (auth)

22331 NEUTRALIZATION OF INTERMEDIATE IONS IN THE RADIOLYSIS OF ETHYLENE BY CHARGE EXCHANGE. G. G. Meisels (Union Carbide Corp., Tuxedo, N. Y.). J. Chem. Phys., 42: 3237-40(May 1, 1965).

The presence of nitric oxide and other additives of low ionization potentials during the radiolysis of ethylene markedly enhanced the formation of butene-1 and cis- and trans-butene-2. Yields of 1.4 to 1.6 molecule/100 ev absorbed in ethylene were reached at additive concentrations of 10 to 15%. The isotopic distribution of the butenes resulting from the radiolysis of ethylene–deuteroethylene–nitric oxide mixtures was typical of a molecular association mechanism, while the combined effects of electrostatic fields and nitric oxide demonstrated the absence of free radicals and excited species as precursors. The results suggested that intermediate butene ion produced by an ion–molecule association process of ethylene parent ion is relatively long lived and may be neutralized by charge exchange. This process apparently competes effectively with further ion–molecule reactions or unimolecular dissociation of $[C_4H_8^+]$. The inference that $G(C_2H_4^+) \leq 1.5$ ion/100 ev was in good agreement with the estimate $G(C_2H_4^+) = 1.5$ based on mass-spectrometric fragmentation patterns for 70-ev electrons. (auth)

22332 RADIOLYSIS OF BINARY PARAFFIN-OLEFIN SOLUTIONS. CYCLOPENTENE AND CYCLOHEXENE IN CYCLOPENTANE AND CYCLOHEXANE. John Y. Yang and Inge Marcus (North American Aviation Science Center, Thousand Oaks, Calif.). J. Chem. Phys., 42: 3315-19 (May 1, 1965).

Radiolyses of binary paraffin–olefin solutions consisting of cyclopentene and cyclohexene in cyclopentane and cyclohexane were carried out. Through a complete analysis of the product distribution for each of the paraffin–olefin pairs at varying olefin concentrations, it was concluded that the nature of the solvent-solute interaction must consist of both hydrogen-atom scavenging and energy or charge transfer. Large yields of diolefinic dimers were observed

even at olefin concentrations as low as 1%, and these yields were attributed largely to nonradical processes following preferential energy licalization in the olefins. It is suggested that hydrogen-atom scavenging processes predominate at very low olefin content, but physical interaction becomes the more important factor as the olefin concentration is increased beyond about 1%. (auth)

22333 ON THE ORIGIN OF SOME HYDROGEN ISOTOPE EFFECTS IN IRRADIATED AQUEOUS SOLUTIONS. Chava Lifshitz and Gabriel Stein (Hebrew Univ., Jerusalem). J. Chem. Phys., 42: 3330-1(May 1, 1965).

The hydrated electron formed in irradiated water reacts in acidified solutions according to: $e^-_{aq} + H^+_{aq} \rightarrow H$. In a mixture of light and heavy water the hydrogen atoms formed are richer than the irradiated water in light hydrogen. It was concluded that in acid solutions there is a longer-lived intermediate in the reaction, and that this leads to a larger isotope effect. (M.C.G.)

22334 MATRIX EFFECTS ON THE STRUCTURE OF FREE RADICALS IN SOLID PHASE: EPR STUDY OF IRRADIATED NH_3 AND ND_3. R. Marx (Faculte des Sciences, Orsay, France) and J. Maruani. J. Chim. Phys., 61: 1604-9(Nov.-Dec. 1964). (In French)

By the EPR (electron paramagnetic resonance) study of a polycrystalline solid, deformation of the $-NH_2$ and $-ND_2$ radicals in a matrix of mother molecules was studied. This deformation, which is shown by a modification of the isotropic coupling constants and by an at least partial blocking of the free rotation under certain conditions, can have its origin in the existence of intermolecular hydrogen bonds in the solid. These H bonds can equally favor the transfers of hydrogen between the molecules and the radicals, thus producing the migration of the latter and their recombination in spite of the rigidity of the medium. (tr-auth)

22335 A GEOCHEMICAL INVESTIGATION UPON THE EFFECTS OF IONIZING RADIATION ON HYDROCARBONS. Umberto Colombo, Giuseppe Sironi, and Ennio Denti (Montecatini Co., Novara, Italy). J. Inst. Petrol., 50: 228-37(Sept. 1964).

n-Heptane, cyclohexane, and benzene, as well as two Italian crude oils, were irradiated with γ rays and neutrons in a swimming-pool reactor, both alone and in the presence of sedimentary rocks and water. Gas consisting of hydrogen and a mixture of saturated and unsaturated hydrocarbons was obtained, together with a liquid of higher density and molecular weight than the original material. In general, radiolysis was more pronounced when rocks and water were present, but there were lower concentrations of free hydrogen and unsaturated hydrocarbons in the gas than when the hydrocarbon or oil was treated alone. Crude oils, on radiolysis, showed an increase in the contents of resins and asphaltenes. The effect was enhanced by the presence of rock and water. Associated with this there was less sulfur in oily components, and more in the resins and asphaltenes after irradiation. Some radioactive shales, commonly considered to be petroleum source rocks, may instead have acted as filters for migrating hydrocarbons, and caused their alteration by radioinduced reactions. (REIC)

22336 EFFECT OF COBALT-60 γ RADIATION ON DIPHENYL MERCURY AND TRIPHENYLBISMUTH IN SOLUTION OF BENZENE AND CHLOROFORM. Charles Heitz and Jean-Pierre Adloff (Centre de Recherches Nucleaires, Strasbourg). J. Organometal. Chem. (Amsterdam), 2: 59-67(June 1964). (In French)

The effects of ^{60}Co γ radiation on solutions of diphenylmercury (Ph_2Hg) and triphenylbismuth (Ph_3Bi) in benzene and chloroform are described. Radiation sensitivity was greater for Ph_2Hg. In benzene, the radiolytic decomposition led to the metal and free radicals whereas in chloroform the organometallic halides PhHgCl and Ph_3BiCl_2 were formed. In the latter case, reaction occurred through the radiolytic products of the solvent. (auth)

22337 LINEAR ENERGY TRANSFER EFFECTS IN THE RADIOLYSIS OF LIQUID AROMATIC HYDROCARBONS. J. Y. Yang, J. D. Strong, and J. G. Burr (North American Aviation Science Center, Thousand Oaks, Calif.). J. Phys. Chem., 69: 1157-61(Apr. 1965).

Liquid benzene and o-terphenyl were exposed to radiations of LET values ranging from 0.02 to 25 ev/Å; $G(H_2)$ and G(reactant → polymer) values were determined under these conditions. There was little change in product yields for radiations with LET from 0.02 to 2 ev/Å, but the yields increased sharply with LET above 2 ev/Å. A number of observations cannot be explained by a reaction model based on competition between a unimolecular reaction and a bimolecular reaction involving activated species. It is suggested that these observations may be explained by thermal spike effects. (auth)

22338 THE RADIOLYSIS OF ACETONE IN AIR-FREE AQUEOUS SOLUTIONS. Peter Riesz (National Cancer Inst., Bethesda, Md.). J. Phys. Chem., 69: 1366-73(Apr. 1965).

Products from the radiolysis of aqueous air-free acetone solutions were identified as 2,5-hexanedione, isopropyl alcohol, hydroxyacetone, hydrogen peroxide, and hydrogen. Their yields were determined over a wide range of concentration (10^{-3} to 1M) and pH (1.0 to neutral). The marked dependence of the yields of isopropyl alcohol, 2,5-hexanedione, and hydrogen on both pH and acetone concentration can be understood in terms of the competition of acetone and hydrogen ions for the hydrated electron formed by the irradiation of water. Hydrated electrons react either with acetone to form an anion radical, which is the precursor of isopropyl alcohol, or with hydrogen ions to give hydrogen atoms. About two-thirds of the hydrogen atoms produced react with acetone by abstraction to give acetonyl radicals and hydrogen gas, and the remainder reacts by addition. This mechanism was supported by the effect of addition of n-propyl alcohol to acetone solutions before radiolysis. As a good scavenger for H and OH but a very poor one for hydrated electrons, n-propyl alcohol suppressed the formation of 2,5-hexanedione but not that of isopropyl alcohol. (auth)

22339 RATE CONSTANTS OF SOME REACTIONS OF H ATOMS IN AQUEOUS SOLUTION. Gil Navon and Gabriel Stein (Hebrew Univ., Jerusalem). J. Phys. Chem., 69: 1384-9(Apr. 1965).

Using a variety of scavengers, the rate constants of their reactions with atomic hydrogen in aqueous solutions were compared when H atoms are produced in the gas phase by a high-frequency electrodeless discharge and introduced into the aqueous solution and by irradiation of the aqueous solution. With the help of this comparison it is shown that the diffusion model proposed previously may be used for calculation of the rate constants from experiments using the first method. The reaction of atomic hydrogen with nitrate and nitrite ions was investigated under various conditions and rate constants determined. Phosphate ions inhibited these reactions, probably through complex formation with atomic hydrogen. Hydroxyl ions catalyzed them, probably through the formation of hydrated electrons. (auth)

22340 PRODUCTION, IDENTITY, AND ANNEALING OF THE RADIOLYTIC PRODUCTS FORMED IN CRYSTALLINE CESIUM BROMATE BY COBALT-60 γ-RAYS. G. E. Boyd and Q. V. Larson (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 69: 1413-19(Apr. 1965). (ORNL-P-792)

Yields for bromate ion decomposition and for the production of oxygen, bromide ions, and oxidizing fragments in the radiolysis of crystalline $CsBrO_3$ by ^{60}Co γ rays were determined as a function of dose, temperature, and dose rate. At 57°C all of the yields except those for $O_2(g)$ increased nonlinearly with dose. For large doses the concentration of oxidizing fragments became constant, and further radiolysis produced bromide and oxygen. Radiolysis at 300°C gave only bromide and oxygen; at lower temperatures increasing amounts of oxidizing fragments including hypobromite, bromite, and bromine species with higher oxidation numbers were formed, and the amounts of Br^- and $O_2(g)$ decreased. The radiolytic decomposition of BrO_3^- increased from −196 to 40°C and then decreased with increasing temperature until a maximum stability was

reached at about 100°C; at 200°C the decomposition was nearly the same as at 40°C, and at 300°C it was significantly greater. Post-irradiation heating of the crystals removed their color, alkaline reaction, and oxidizing properties, increased their bromide content, and decreased the initial bromate decomposition. The yields of all the radiolysis products were independent of the dose rate. The behavior of the thermally labile oxidizing fragments was explained in terms of their decomposition to bromide and oxygen and back-reaction to re-form bromate ion. The reaction of BrO_3^- ion with lattice oxygen produced thermally or by γ rays is proposed to account for the annealing of the chemical radiation damage produced in $CsBrO_3$. (auth)

22341 DIRECT OBSERVATION OF CRYSTAL IMPERFECTIONS INTRODUCED BY WEAK ELECTRON IRRADIATION IN WATER-ETCHED KCl SINGLE CRYSTAL. Yasuhiro Kawamata and Tadatosi Hibi (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 20: 242-50(Feb. 1965).

The changes in a water-etched KCl single crystal due to weak electron irradiation were observed by means of an electron microscope and by electron diffraction. It was found that in a crystal becoming thicker with distance from the edge dislocation loops appeared with observable development. When the change of the thickness of the crystal was pronounced, large dislocation loops were found in the thin part close to the edge of the crystal. For a dislocation loop less than 0.5 μ in diameter, the loop changed abruptly into one void with weak electron irradiation. However, a larger dislocation loop changed into one void and several small dislocation loops. Interactions between two crystal imperfections were also observed in this experiment. The mechanism of coagulation or dispersion of vacancies in water-etched KCl crystals under weak electron irradiation is discussed, using the experimental results. (auth)

22342 BRANCHING IN POLY(BUTADIENE-CO-STYRENE). II. RADIATION-INDUCED BRANCHING EXAMINED BY VISCOMETRY. J. Blachford and R. F. Robertson (McGill Univ., Montreal). J. Polymer Sci. Pt. A, 3: 1303-11(Apr. 1965).

The dependence of intrinsic viscosity on radiation dose was examined for poly-(butadiene-co-styrene) irradiated in vacuo and for mixtures of this polymer and N-phenyl-β-naphthylamine irradiated in air and in vacuo. If no correction is made for crosslinking in the unirradiated polymer, theories examined appear to overestimate the increase in intrinsic viscosity. However, if it is assumed that in the unirradiated polymer the number of crosslinked units per weight-average primary molecule δ_0 is 0.65, the results agree with the theory of Spiro which uses the Stockmayer-Fixman relation between intrinsic viscosity and branching. The dose required for incipient gelation, R_g was determined for the various samples. These results were used together with the number-average molecular weight of the unirradiated polymer and with assumed values of δ_0 to calculated values of G_x, the number of crosslinks formed per 100 ev of radiation energy absorbed by the sample. Good agreement with solubility and swelling results, reported elsewhere, was obtained if $\delta_0 = 0.9$. (auth)

22343 BRANCHING IN POLY(BUTADIENE-CO-STYRENE). III. RADIATION-INDUCED BRANCHING EXAMINED BY SOLUBILITY AND SWELLING. J. Blachford and R. F. Robertson (McGill Univ., Montreal). J. Polymer Sci. Pt. A, 3: 1313-24(Apr. 1965).

The dependence of solubility and swelling on radiation dose was examined for pure polymer and polymer containing varying amounts of the antioxidant N-phenyl-β-naphthylamine. Degradation did not occur when samples were irradiated in vacuo but in the presence of air degradation was initiated and crosslinking was retarded. During irradiation in vacuo the antioxidant interacted with the polymer and prevented the formation of a large number of crosslinks. An analysis of the solubility data indicated that there were 0.9 crosslinked units per weight-average primary molecule in the unirradiated polymer, and that 1.59 crosslinks were formed in the pure polymer on the absorption of 100 ev of radiation energy (i.e., $G_x = 1.59$). These values are consistent with the swelling data but not with the experimentally determined molecular weight distribution. (auth)

22344 BRANCHING IN POLY(BUTADIENE-CO-STYRENE). IV. RETARDATION OF RADIATION-INDUCED BRANCHING. J. Blachford and R. F. Robertson (McGill Univ., Montreal). J. Polymer Sci. Pt. A, 3: 1325-35(Apr. 1965).

The composition and yield of the evolved gas and the resulting changes in infrared and ultraviolet spectra were examined for the irradiation of poly(butadiene-co-styrene). Apart from crosslinking, the major changes that occurred during the reaction were the evolution of hydrogen and the destruction of vinyl groups. For every 100 ev of radiation energy absorbed 0.45 molecules of hydrogen were evolved, $G(H_2) = 0.45$, and 6.1 vinyl groups were destroyed, G(-vinyl) = 6.1. These results were compared with the yield of crosslinks, $G_x = 1.60$. Addition of N-phenyl-β-naphthylamine to the polymer reduced the gas yield to a greater extent than predicted by the mixture law (which states that the yield of a product from component X is directly proportional to the electron fraction of X). Over the additive concentration range of 2–11%, the gas yield was constant. This behavior is identical to that found previously for the crosslink yield. An explanation of these results is given that involves the occurrence of processes that exhibit a negative deviation from the mixture law together with processes that exhibit a positive deviation. The destruction of the additive during the irradiation of a sample containing initially 0.52% additive was determined. The results indicate that the additive protects the polymer mainly by charge transfer or excitation energy transfer. (auth)

22345 RADIATION-INDUCED POLYMERIZATION AND OTHER REACTIONS OF n-PERFLUOROPENTADIENE-1,4 AT HIGH TEMPERATURE AND PRESSURE. D. W. Brown, J. E. Fearn, and R. E. Lowry (National Bureau of Standards, Washington, D. C.). J. Polymer Sci. Pt. A, 3: 1641-60(Apr. 1965).

The radioinduced polymerization of n-perfluoropentadiene-1,4 was studied at temperatures of 100–170°C and pressures of 8,000–15,000 atm. Kinetic evidence indicates that polymerization occurs by a free radical reaction; the activation energy is between 14 and 17 kcal/mole and the activation entropy is -8 ± 5 eu/mole. Transfer with monomer limits the number-average degree of polymerization to values of 40 or less except in special circumstances. Dimerization and double bond migration occur to some extent; n-perfluoropentadiene-1,3 is formed in the latter process. It and the 1,4-diene copolymerize; the latter undergoes cyclic addition so that the polymers are soluble and have little perfluorovinyl unsaturation. The polymers are brittle if the fraction of 1,3-diene in the polymer is less than 0.1. They are rubbery and of considerably higher molecular weight if the fraction of 1,3-diene is greater than 0.4. The thermal stability of the polymers decreases as the content of 1,3-diene increases. (auth)

22346 LIGHT AND RADIATION CATALYZED REACTIONS IN ORGANIC SYNTHESIS. K. Okaka and K. Isawa. Kagaku Kojo, 7: No. 6, 22-9(1963). (In Japanese)

Processes involving chain reactions initiated by light or radiation can usually be operated continuously at comparatively low temperatures resulting in products of high purity without contamination of added catalysts. On the other hand such reactions are sometimes hard to control because of their high reaction speed with resulting by-product formation, and proper protection must be provided when γ and x rays are used as the radiation source. Light catalyzed chlorination of butyric acid, its acid chloride, methyl ester, and nitrile causes β-chlorination, and offers β-substituted compound as the major product in each case. Whereas chlorination of adipic acid in the presence of benzoyl peroxide gives the β, β'-dichloro derivative, light causes the formation of the α, α'-tetrachloro- β, β'-dichloro compound. Benzene hexachloride is made industrially by chlorination of benzene under the influence of sunlight or fluorescence radiation. Gamma irradiation of

an alcohol molecule causes the formation of a hydrogen atom (H.) and an α-carbon radical (RĊHOH) which, in turn, attacks an olefinic molecule resulting in an additional product. Similarly, the following classes of compound form addition products across the double bond of olefins by means of light and radiation via the chain reaction mechanism: mercaptans, amines, aldehydes, hydrocarbons, and polyhalogenohydrocarbons. Substituted iodobenzenes in benzene solution under ultraviolet light yield the corresponding diphenyl derivatives in 60 to 70% yields. Amino acids were delected among the radiation products of certain mixtures of organic and inorganic compounds. A 84% yield of hydrazine was effected through irradiation of ammonia. In the reaction of a hydrocarbon with a mixture of chlorine and sulfur dioxide under ultraviolet radiation (Reed's reaction), the extent of conversion to alkyl sulfonyl chloride was found to be proportional to the intensity of the radiation applied. By using oxygen in place of chlorine in Reed's reaction, sulfonated products were obtained directly (sulfoxidation). In the latter case, hydrocarbons, chloroparaffins, alcohols, ethers, esters, carboeylic acids, acyl chlorides, amides, and nitrites were used as reactants. In photoinduced sulfoxidation it was concluded that peroxide is probably involved as intermediate. Thus, in the presence of water, the peracid is converted to the corresponding sulfonic acid and sulfuric acid or in the presence of acetic anhydride, a comparatively stable acetylalkyl-sulfonyl peroxide is formed and then it reacts with sulfur dioxide and water to give sulfonic acid, acetic acid, and sulfuric acid. According to the nonchain reaction mechanism proposed by Topchiev, sulfonation should primarily take place on secondary carbon atom. However, the results obtained indicated otherwise. Identification of the sulfoxidation products obtained by applying both ultraviolet and γ rays (^{60}Co) revealed that, sulfonation takes place at end carbon atom. (52 references.) (NFSAIS)

22347 CERTAIN FEATURES OF THE IRRADIATION OF LUBRICANTS DURING THE DETERMINATION OF THEIR RADIATION RESISTANCE. Yu. S. Zaslavskii, A. D. Stukin, and G. I. Shor. Khim. i Tekhnol. Topliva i Masel, No. 10, 44-8(1964).

A calorimetric dosimeter was designed for use in determining the radiation resistance of lubricants. The technique is based on the principle that virtually all absorbed radiation is converted into heat. The dosimeter was used for calibrating reactor fuel element channels prior to lubricant irradiation experiments. The calibration performed, using a polyethylene pickup, was in terms of dose rates as a function of distance from center, thermal neutron flux, and sample temperature. These data made it possible to select the proper channel, depending on the predetermined thermal conditions of the experiment, and to calculate the irradiation time for a desired absorbed dose. One advantage of this dosimeter is that the lubricant to be irradiated can be used as the pickup. A special can was designed for the lubricant irradiation experiments. Irradiation test results for various mineral oils showed that the higher the initial viscosity, the greater is the viscosity rise due to irradiation. (CFSTI)

22348 RADIATION VULCANIZATION OF NATURAL RUBBER IN SOLUTION. Kenji Murayama and Yasuo Shinohara (Toyo Rayon Co., Japan). Kobunshi Kagaku, 21: 710-15(Nov. 1964). (In Japanese)

Radiation vulcanization of natural rubber in solution was studied. Natural rubbers dissolved in various solvents were irradiated by γ rays from ^{60}Co in vacuum and swelling ratios were measured to obtain the degree of vulcanization. The rate of vulcanization was fast in solvents having large G-values of radical formation, and radical scavengers, such as DPPH and nitrobenzene, inhibited or retarded the vulcanization. It was concluded, therefore, that the vulcanization in this system was due to the indirect radical mechanism. Kinetic studies showed that the rate of vulcanization was proportional to the square root of radiation dose rate, proportional to the rubber concentration in the low concentration range, or independent of the concentration in the high concentration range. The experimental results show good agreement with the above theoretical results. Effects of irradiation temperature were also studied and as an apparent activation energy, 6.8 kcal/mole was obtained. (auth)

22349 RADIATION-INDUCED COPOLYMERIZATION OF MALEIC ANHYDRIDE WITH STYRENE. Yoneho Tabata and Munemasa Shu (Tokyo Univ.). Kogyo Kagaku Zasshi, 67: 2156-9(Dec. 1964). (In Japanese)

Radioinduced copolymerization of maleic anhydride with styrene was carried out in bulk and in chloroform solution. An extremely rapid copolymerization was observed in the solution, where there was no induction period. The copolymerization was completely inhibited by 2,2′-diphenylpicrylhydrazyl and pyrogallol. Activation energies of 5.1 and 4.8 kcal/mole were obtained for bulk (3.6 mole % maleic anhydride in the monomer mixture) and solution (8 wt % of the equi-molar mixture for the chloroform solution) polymerizations, respectively. From these experimental results, it was evident that these copolymerizations proceed by a radical process. The infrared spectra and elementary analyses of the copolymer indicated that the copolymer has an alternating structure in a wide range of monomer concentration of one component. (NSA of Japan)

22350 RADIATION-INDUCED COPOLYMERIZATION OF α-METHYLSTYRENE WITH MALEIC ANHYDRIDE. Munemasa Shu and Yoneho Tabata (Tokyo Univ.). Kogyo Kagaku Zasshi, 67: 2159-63(Dec. 1964). (In Japanese)

Radioinduced copolymerization of α-methylstyrene with maleic anhydride was carried out in bulk and in solution. Effects of temperature, dose rate, molar concentration of one component in the monomer mixture, and radical scavengers on the copolymerization were investigated. Infrared spectra and the melting points of the copolymers obtained were measured. An elementary analysis of the copolymer was also carried out. The copolymerizations were not preceded by an induction period. It was observed that the copolymerization was completely inhibited by 2,2′-diphenylpicrylhydrazyl (DPPH) and pyrogallol. Apparent activation energies of 6.7 and 5.4 kcal/mol were obtained for bulk copolymerization (3.6 mole % of maleic anhydride for α-methylstyrene) and for solution copolymerization (8 wt% chloroform solution of an equi-molar mixture of both monomers), respectively. It was concluded from both infrared and elemetary analyses of the copolymer that a homopolymerization of each monomer did not take place under the experimental conditions used and that an alternating copolymerization possibly took place in a wide range of monomer concentration of one component. (NSA of Japan)

22351 ENVIRONMENTAL EFFECTS ON RADICAL SPECIES IN IRRADIATED POLY(BUTENE-1). Kenzi Hukuda and Naoshi Kusumoto (Kyushu Univ., Japan). Kogyo Kagaku Zasshi, 67: 2163-7(Dec. 1964). (In Japanese)

ESR measurements were carried out on two different samples of gamma-irradiated poly(butene-1); one was semicrystalline and the other was amorphous obtained by cooling its melt to liquid nitrogen temperature. Hyperfine spectra of both samples had diffused sextet line shapes below −120°C. They became sharper in the temperature range −120 to −70°C. Above −70°C a quartet structure became dominant for the amorphous sample and an octet structure for the semicrystalline one. Spectra of the semicrystalline sample obtained at about −60°C contained the octet, which was obtained by annealing at room temperature and assumed to be characteristic of the crystalline region, in addition to the quartet observed for the amorphous sample. The ESR spectra suggested that two phases exist in the texture of the semicrystalline sample. Free radicals, which give these quartet and octet spectra, are thought to interact equally with three and seven protons, respectively. With supplementary experiments such as gas analysis using a mass spectrometer and comparison of intrinsic viscosity before and after irradiation, it was suggested that the radicals giving the quartet are produced by scission of the main chains. They apparently change their structures in the crystalline region by migration of pro-

tons to give the octet in the temperature range from −70°C to room temperature. (NSA of Japan)

22352 A STUDY ON ANTI-RADIATION GREASES. Noboru Furuya (Meidensha Electric Mfg. Co., Ltd., Japan). Meidensha Jiho, No. 57, 31-7(Oct. 1964). (In Japanese)

The effects of ^{60}Co γ rays on some lubricating greases and base oils were studied. The changes of viscosity, acid value, and refractive index were observed at doses up to 3×10^8 R for five base oils: 60 spindle oil (aromatic content 36%) (A), 60 spindle oil (aromatic content 68%) (B), NRRO 360 (anti-radiation type) (C), phenylmethyl silicone fluid (D), and diphenyl trichloride (E). Viscosity increased in A, D, and E, but there was almost no change in B and C. The increase in the acid value was relatively small except for E; in the latter, a large amount of acid was found (acid value 0.324 at 1.0×10^8 R). The refractive index was increased slightly in A, B, D, and E; the refractive index decreased in C. Four kinds of grease, a kind of cup grease (F), APL 700 (anti-radiation type) (G), NRRG 235 (anti-radiation type) (H), and silicone grease (I), were irradiated up to 2×10^8R, and the changes of consistency (worked and unworked), dripping point, oil separation, and free acid were observed. G and H were found to be very satisfactory for use in a radiation environment, although free acid was increased somewhat. In general, the consistency increased at first, due to destruction of the fibril structure, and then decreased. It was concluded that F, G, H, and I may be used at radiation doses up to 1×10^7, over 1×10^8, over 1×10^8, and 3×10^6 R, respectively. Electron-microscopic photographs of unirradiated and irradiated greases are given. (NSA of Japan)

22353 IRRADIATION EFFECTS ON FLUOROCARBON PLASTICS. I. PREVENTION OF DISTORTION CAUSED BY FABRICATION OF POLYTETRAFLUOROETHYLENE. Shozo Iida and Hiroshi Sakami (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kagyo Gijitsu Shikensho Hokoku, 13: 417-22(Nov. 1964). (In Japanese)

Polytetrafluoroethylene is one of the most difficult resins to fabricate without distortion because of its extremely high melt viscosity. The possibility of the prevention of distortion was studied by applying the chemical stress relaxation induced by γ irradiation. It was found that the rate of chemical stress relaxation was remarkably accelerated by γ irradiation. It took about 24 hr for the stress to relax to half of the initial value without irradiation, but took only 15 min with γ irradiation at a dose rate of 0.3 MR/hr. This fact indicated the possibility of prevention of distortion caused by fabrication. Deformation at room temperature after fabrication was not observed when irradiated more than 0.3 MR, and the heat distortion at 250°C was almost negligible when irradiated more than 1 MR. The rate of recovery after the removal of pressure with which the resin was fixed at a given length was decreased with the increase of irradiation dose. This fact seemed to be useful in correcting the size of distorted resins. (auth)

22354 RADIATION-INDUCED OXIDATION OF PERFLUOROPROPYLENE. M. Lenzi and A. Mele (C.N.E.N., Rome and Universita, Rome). Nature, 205: 1104-5(Mar. 13, 1965).

It was found that perfluoropropylene is completely oxidized by molecular oxygen when irradiated in the gas phase with γ rays from a ^{60}Co source. The dose rate was 0.35 MR/hr, and the mixtures were irradiated for 25 hr. The oxygen uptake by the olefin is about 1.2 on a molar basis and this also occurs when the reactants are in a 1:1 ratio. The reaction products are mainly gaseous at room temperature, and carbonyl fluoride and trifluoroacetyl fluoride account for 80% of the total pressure (50% of the olefin consumed). (C.E.S.)

22355 ELECTRON SPIN RESONANCE SPECTRA OF POLYMETHYL METHACRYLATE AFTER EXPOSURE TO NITRIC OXIDE AND NITROGEN DIOXIDE. M. Ebert and J. Law (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature, 205: 1193-6(Mar. 20, 1965).

Studies showed that nitric oxide (NO) reacted with powdered samples of polymethyl methacrylate (PMMA) to give free radicals with an asymmetric ESR signal, which arose from a reaction between the gas and traces of unreacted methyl methacrylate monomer (MMA) in the PMMA samples. Nitrogen dioxide (NO_2) also had a similar effect. The signal, whether produced by NO or NO_2, is stable for periods of months in either air or vacuum. It is also stable in the presence of NO for a few weeks at least, but decays in the presence of NO_2. It is unaffected by radiation at doses of at least 10^7 Rads. (P.C.H.)

22356 THERMAL DECOMPOSITION OF IRRADIATED STRONTIUM AZIDE. E. C. Prout and D. J. Moore (Rhodes Univ., Grahamstown, South Africa). Nature, 205: 1209-11 (Mar. 20, 1965).

Pre-irradiation effects on the thermal decomposition of strontium azide were investigated. Gamma irradiation (20 MRads) at room temperature, in vacuo, induced a light-grey color in the salt. On subsequent thermal decomposition, the power law no longer fit the acceleratory region of the p/t plots for pre-irradiated azide. Conformity to the power law with n = 3 with unirradiated crystals indicated reaction at a fixed number of nuclei and the growth of these reaction centers in a three-dimensional manner. Below 1 MRad neither the power law nor exponential law held throughout the acceleratory period although the extent of fit of the power law improved with decreasing dose, and with a 1,000 Rad specimen the fit was from $\alpha = 0.03$ to $\alpha = 0.5$. The decay reaction is described by the unimolecular decay law. (P.C.H.)

22357 UNPAIRED ELECTRONS IN ULTRA-VIOLET-IRRADIATED KERATIN. J. L. Dunlop and C. H. Nicholls (Univ. of New South Wales, Kensington, Australia). Nature, 205: 1310-11(Mar. 27, 1965).

In experiments with uv-irradiated proteins and amino acids, results were obtained that in a particular instance may support the theory that proteins may exhibit conduction band properties. Several amino acids and the proteins gelatin, insulin, casein, silk fibroin, egg albumin, and unpigmented keratin samples were irradiated by narrow wave length bands of monochromated uv radiation in the spectral range 250-600 mμ to doses of the order of 10^{20} quanta. Radiations of wave lengths greater than 325 mμ, produced no significant electron spin resonance signal in any of the proteins with the exception of the keratin samples. In the case of the unpigmented keratins (various types of wool and rhinoceros horn), a strong electron spin resonance signal (approximately 10^{14} spins/g) was observed after irradiation at the wave length intervals of 325-360, 360-400, and 400-600 mμ. It was concluded that the conduction band could be associated with some non-protein impurity in the form of either melanin pigmentation (in minute quantities since the keratin samples appeared to be unpigmented) or some unpigmented precursor to melanin. (P.C.H.)

22358 THERMAL DECOMPOSITION OF IRRADIATED CALCIUM AZIDE. E. G. Prout and M. E. Brown (Rhodes Univ., Grahamstown, S. Africa). Nature, 205: 1314-15 (Mar. 27, 1965).

Studies were made on the thermal decomposition of calcium azide to determine whether: the reproducibility of the decomposition could be improved; reliable activation energies could be obtained; and the uncertainty relating to the correct kinetic expressions for the decomposition could be resolved. It was found that reproducibility of results was excellent. The acceleratory period conformed to the power expression, and the decay reaction to the contracting sphere formula. The activation energy for processes occurring during the induction periods, as determined from the plot of log (induction period) versus 1/T (°K) was 18.2 kcal $mole^{-1}$. Pre-irradiation experiments showed that the power expression and the contracting sphere formula fitted the pressure-time plots for the decomposition of x; uv-, and γ-irradiated calcium azide. Activation energies for the decomposition of γ-irradiated azide were 19.8, 28.1, and 22.5 kcal $mole^{-1}$ for the induction, acceleratory, and decay periods, respectively. (P.C.H.)

22359 RADIATION POLYMERIZATION OF n-HEPTENE IN THE PRESENCE OF $TiCl_4$. Yu. A. Kolbanovskii, L. S. Polak, and E. B. Shlikhter. Neftekhimiya, 3: 222-6 (Mar.-Apr. 1963). (In Russian)

The radiation polymerization, using a ^{60}Co source, of n-heptene-1 in the presence of $TiCl_4$ and the influence of the dose, dose strength, radiation temperature, amount of catalyst, and dilution on the yield of the polymer were studied. It is shown that with dilute solutions and at low temperatures, the optimum conditions are created for polymerization with $TiCl_4$. In calculating the absorption energy for a monomer, the values of the radiochemical yields were about 50 mol/100 ev. It was established that the polymer yield depended on the dose strength to a degree of 0.8. (O.I.D.)

22360 ON THE THEORY OF THE RADIOPHOTOLUMINESCENCE IN GLASSES. PART I. Helmut Vogel and Klaus Becker (Technische Hochschule, Munich and Kernforschungsanlage, Julich, Ger.). Nukleonik, 7: 18-33 (Jan. 1965). (In German)

For the qualitative and quantitative theoretical interpretation of radiophotoluminescence (RPL) in activated glasses, a simple band model was formulated and confirmed. The calculation method used was briefly described and the stationary behavior and the kinetics of the RPL rise after the end of irradiation were calculated with special consideration of silver-activated metaphosphate glasses. (tr-auth)

22361 COMPARATIVE RECOIL EXPERIMENTS WITH METAL PHENYL COMPOUNDS. R. F. C. Claridge, E. Merz, and H. J. Reidel (Kernforschungsanlage, Julich, Ger.). Nukleonik, 7: 53-8 (Feb. 1965).

The high-energy recoil products produced in solids and liquids by nuclear reactions may react with surrounding molecules forming various amounts of different labeled radioactive compounds. Comparative studies of the products formed by (n,γ) and (n,2n) processes were made on the metal phenyl compounds of germanium, tin, lead, arsenic, and antimony. Applying different separation methods, e.g., adsorption chromatography on alumina, ion exchange, and electrophoresis, the various radioactive recoil products were separated and the individual yields determined. It was found that in nuclear reactions the compounds of the metals with identical ligands form practically the same classes of recoil products. The yield distribution however revealed characteristic alterations between the (n,γ) and the (n,2n) reactions. Only a small influence on the yields was perceptible when irradiations were performed in liquids and solutions, respectively. The results are discussed on the basis of theoretical considerations of the amount of kinetic energy transferred to the reacting molecule by nuclear recoil and the resulting excitation. The hypothesis is put forward that the kind and quantity of certain radioactive species produced in connection with nuclear events is less a function of the nature and concentration of primary recoil fragments than are the ions, radicals, and lattice defects imparted to the irradiated materials by secondary recoil effects (elastic and inelastic interactions), including the peculiar influence of oxygen present in the irradiated samples. (auth)

22362 X-RAY GENERATION OF F CENTERS IN KCl WHISKERS. S. Ballaro, G. Chiarotti, G. Cubiotti, and V. Grasso (Univ. of Messina, Italy). Phys. Chem. Solids, 26: 729-34 (Apr. 1965).

The growth of the F band under x-irradiation was studied in KCl whiskers of various purities. Darkening occurred in two stages as in ordinary crystals. Stage 1 was, however, much greater in whiskers, showing that they contain a large initial concentration of vacancies or vacancy clusters. A reason for this behavior is briefly outlined, based on the observed dislocation pattern in the whiskers. Though the measured dislocation content of the whiskers was an order of magnitude smaller than in ordinary (Harshaw) crystals no significant differences in stage 2 coloration were found to support a dislocation mechanism of vacancy production. The d-c conductivity of whiskers was also studied as a function of temperature. The results showed that whiskers have a remarkable degree of purity. (auth)

22363 CsI(Na) SCINTILLATION CRYSTALS. P. Brinckmann (Universitat, Bonn). Phys. Letters, 15: 305 (Apr. 15, 1965).

It was found that CsI(Na) is a very efficient scintillator. Crystals were grown from the melt starting with CsI and additions of NaI. It was found that CsI could be activated as well by addition of NaOH, NaF, or NaBr, while addition of K, Be, or Mg yielded no effect and addition of Li, Ca, Sr, or Ba very little effect. The emission spectrum of CsI(Na) at room temperature under β excitation from a ^{90}Sr-^{90}Y source is illustrated. (C.E.S.)

22364 OPTICAL PROBING OF THE ENVIRONMENT OF F CENTERS IN DEFORMED ALKALI HALIDES. R. Chang (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev., 138: A839-44 (May 3, 1965).

The formation of F centers upon ^{60}Co irradiation of KCl deformed at room temperature and at 77°K and the environment of F centers formed upon ^{60}Co irradiation of deformed KBr were studied by means of optical-absorption measurements with a Cary-14 spectrophotometer. Anomalies of the beta absorption band (exciton band localized at the F centers) and shift of the F-center peak toward blue were observed in deformed KBr at 10 and 80°K. The observed anomalies can be removed by a short annealing near 525°K. Both the dichroic behavior of the beta band and the energy shift of the F band are consistent with the hypothesis that the source of vacancies is the edge-dislocation dipoles from plastic deformation. The F centers formed upon ^{60}Co irradiation of deformed KBr are most probably located a few Burgers vectors away from the core of one member of the edge-dislocation dipole in the compression region, a fraction of an interatomic spacing above the slip plane where the edge dislocation is situated. (auth)

22365 COLOR CENTERS PRODUCED IN KCl AND KBr BY PROLONGED X IRRADIATIONS AT LOW TEMPERATURES. Bruce J. Faraday and W. Dale Compton (Naval Research Lab., Washington, D. C.). Phys. Rev., 138: A893-911 (May 3, 1965).

The principal purposes of this study were to observe the effect of an x irradiation of extended duration on the production of color centers in KCl and KBr at low temperatures and to examine the implications with regard to possible color-center models. Growth curves were determined at 5°K for the F, K, M, and H bands in KCl and KBr and for a new band at 245 mμ in KCl and at 278 mμ in KBr, called the H′ band. Growth curves were determined at 80°K for the F, K, and M bands in KCl and KBr. The growth of the V_4 band in KBr and of a band having its absorption maximum at 240 mμ in KCl, designated as the V(240) band, was also followed at 80°K. The ratio of the absorptions at the peak of the F and K bands was found to remain constant indicating that both of these bands arise from transitions in the same center. The concentration of M centers was found to depend quadratically on the F-center concentration. This result gives conclusive support to the model proposed by van Doorn and Haven that the M center consists of a pair of associated F centers. The F-to-H ratio was observed to be constant for short x-ray exposures, supporting the viewpoint that the two centers are produced as complementary defects; however, for prolonged exposures, this ratio is no longer constant. The number of F centers is in constant ratio to the combined concentrations of H and H′ centers provided that the oscillator strength of the H′ band is suitably chosen. The linear dependence of the generation of both V_4 centers in KBr and V(240) centers in KCl on F-center concentration suggests that the V_4 and V(240) centers, rather than V_1 centers, are fundamentally related to the mechanism of formation of F centers near liquid-nitrogen temperature for a prolonged irradiation. (auth)

22366 OPTICAL SPIN POLARIZATION IN M-LIKE CENTERS IN CaO. Douglas H. Tanimoto, William M.

Ziniker, and James O. Kemp (Univ. of Oregon, Eugene). Phys. Rev. Letters, 14: 645-7(Apr. 19, 1965).

An example of spin polarization by broad-band, unpolarized light in M-like color centers, resulting in emissive spin resonance transitions is reported. The ESR spectrum at 300°K of the neutron-irradiated CaO crystals showed the center as a set of six narrow lines, which were assigned to a triplet state of a two-electron system. Light illumination at 4.2 and 1.6°K was found to populate the triplet in a manner in which the three low-field ESR lines are inverted, the intensities varying in an odd-symmetry pattern about the center of the spectrum. A level and optical pumping scheme is suggested which may explain the inverted ESR lines. (L.B.S.)

22367 DYNAMICS OF OXIDATION-REDUCTION PROCESSES IN RARE-EARTH-DOPED CaF_2. Z. J. Kiss and D. L. Staebler (Radio Corp. of America, Princeton, N. J.). Phys. Rev. Letters, 14: 691-3(Apr. 26, 1965).

The oxidation-reduction processes associated with rare-earth-doped CaF_2 crystals subjected to γ irradiation. Under the influence of high-energy radiation, some of the trivalent rare earths convert to the divalent state leaving an unidentified hole behind. The divalent rare earth produced is not stable; it reoxidizes to the trivalent state accompanied by luminescence characteristic of the trivalent rare earth. The mechanism of this reconversion is reported. (C.E.S.)

22368 SULFOCHLORINATION OF POLYETHYLENE UNDER Co^{60} GAMMA-IRRADIATION. R. V. Dzhagtspanyan and V. I. Zetkin. Plasticheskie Massy, No. 10, 5-8(1964).

For sulfochlorination of polyethylene by a mixture of sulfur dioxide and chlorine in a carbon tetrachloride solution initiated by gamma radiation, the effects of the molar ratio of reagents, dose strength, integral dose rate, and extent of the process were studied. It was found to be important in the sulfochlorination of polyethylene to use a radiation dose strength that precludes the possibility of radio-induced crosslinking and also provides a high reaction rate. The optimal dose strength of gamma radiation for the process was found to be within the limits of 0.1 to 2 r/sec. Spectroscopic and x-ray studies showed that no radiation effects are observed in the end product in the dose strength range investigated. (CFSTI)

22369 MÖSSBAUER STUDIES OF CHEMICAL BONDING. J. F. Duncan (Victoria Univ. of Wellington, N. Z.) and R. M. Golding. Quart. Rev. (London), 19: 36-56(1965).

The features of Mösbauer spectroscopy for examining electronic configurations and the structures of chemical compounds are discussed. Fundamental features and theoretical aspects are considered. Internal magnetic fields in molecules, electric-field gradients at nuclei, isomeric or chemical shifts, the $\delta\Delta E_Q$ correlation diagram, temperature dependence of spectra, and other correlations are discussed. The apparatus and isotopes, which can be used, are described. Experimental features of the Mössbauer spectra are outlined. Examples of chemical problems studied using this method are: magnetic structure of compounds, gas-phase adsorption, surface reactions, single-crystal studies, and electronic configurations. (M.C.G.)

22370 REACTION OF HOT BROMINE ATOMS IN LIQUID BINARY SYSTEMS. E. S. Filatov, An. N. Nesmeyanov, and Yu. B. Chepyzhev. Radiokhimiya, 6: 595-604(1964). (In Russian)

The yields of the reaction $^{81}Br(n,\gamma)^{82}Br$ in binary mixtures of methyl bromide with chloromethane were investigated in a wide range of concentrations. It was established that the yield of labeled initial compounds is linearly dependent on the parameter f/ξ (f-geometric probability and ξ-mean logarithmic decrement of energy), which confirms the model of elastic collision. (tr-auth)

22371 REACTION OF CARBON-14 RECOIL ATOMS WITH PYRIDINE AND ITS HOMOLOGS. M. F. Barakat, L. P. Firsova, and An. N. Nesmeyanov. Radiokhimiya, 6: 605-10(1964). (In Russian)

It was established that by exposure of pyridine and its homologs to radiation, labeled compounds were produced and also other compounds such as more complex and simpler heterocyclic compounds. Together with compounds of the heterocyclic series, benzene derivatives were produced. For all the heterocyclic compounds studied the yield of products of substituted hydrogen on CH_3 groups depended on the synthesis of mother compounds since these reactions went by principal forms without modification of the original structure. The yield of products with substituted nitrogen or carbon did not depend on the formation of parent compounds. (tr-auth)

22372 MECHANISM OF REACTION OF ^{14}C RECOIL ATOMS IN INDOLE-CONTAINING SYSTEMS. L. P. Firsova and M. Forys. Radiokhimiya, 6: 610-16(1964). (In Russian)

Data on the yields of a series of labeled products, resulting from exposure of indole to radiation, were obtained. The dependence of the radiochemical yields on the addition of aniline and pyridine was investigated. It is shown that the effects observed can be, on one hand, the results of the radiation protection of the initial compound and, on the other hand, the results of the transfer of energy or charge from excited molecules or intermediary complexes, the stabilization of which leads to the formation of labeled compounds. In connection with the observed change of product yields, the substitutions of hydrogen on recoil carbon in the presence of aniline or pyridine was considered the mechanism of the formation of these compounds. (tr-auth)

22373 REACTION OF CARBON-14 RECOIL ATOMS WITH PYRROL, 2-METHYLPYRROL, AND PIPERIDINE. M. F. Barakat, L. P. Firsova, and An. N. Nesmeyanov. Radiokhimiya, 6: 626-30(1964). (In Russian)

The labeled products of stabilization reactions of ^{14}C recoil atoms in pyrrol and piperidine were investigated. The radiochemical yield of these products was determined. It is shown that, in hydrogenated six-membered heterocycles, the displacement reactions of atoms in molecules by ^{14}C are accompanied by dehydrogenation processes and the opening of cycles. It was established that ring expansion reactions take place in compounds containing the pyrrol group together with the usual heterocycle reactions. (tr-auth)

22374 THE Sb(III)–Sb(V) EXCHANGE REACTION IN HYDROCHLORIC ACID SOLUTIONS. Tomihisa Kambara and Taeko Furuhashi (Shizuoka Univ., Shizuoka City, Japan). Repts. Liberal Arts Sci. Faculty Shizuoka Univ., Nat. Sci., 3: 229-34(Jan. 1964).

Kinetic studies on the Sb(III)-Sb(V) exchange reactions in hydrochloric acid solutions have been reported by N. A. Bonner et al. Their studies are mainly concerned with a rather high concentration of antimony. Some extended studies on more dilute antimony solutions were performed using ^{124}Sb as a tracer. Also some approaches were tried to determine whether or not some radiation effects caused by the tracer can be observed. (auth)

22375 DIFFUSION EFFECT OF STYRENE IN TEFLON ON RADIATION-INDUCED GRAFT COPOLYMERIZATION. Mamoru Kondo and Hiroshi Matsuo (Nihon Telegraph and Telephone Public Corp., Japan). Rev. Elec. Commun. Lab. (Tokyo), 12: 411-23(July-Aug. 1964).

Radioinduced grafting of styrene on Teflon film is controlled by the diffusion of styrene in the material. The interferometric technique was used to follow the process. Influence of several parameters on the distribution of graft concentration was clarified. The plots of the overall graft concentration versus radiation dose rate for various thicknesses of the film indicate that two types of group exist: a group with positive gradients for thin films and one with negative gradient for thick films. The former films show homogeneous grafts, or the inner graft concentrations are partly higher than the surface. The latter films show surface grafts, where the distribution represents a steep falling curve from the surface to the inner part of the film. The boundary of the graft layer is clearly apparent and the thickness decreases with increase in radiation intensity. By the methods of intermittent irradiation and

of irradiation in benzene solution, however, a homogeneous grafting is available for thicker film and with higher intensity. The variation of the distribution curve as the grafting proceeds was observed for comparatively thin film. Although the grafting remains limited to the surface at the incipient time, styrene diffuses progressively into the material as the grafting proceeds, and finally a homogeneous graft copolymer is obtained. The kinetic equation of the process is discussed. (auth)

22376 ELECTRON YIELD IN THE γ RADIOLYSIS OF WATER VAPOR. J. H. Baxendale and G. P. Gilbert (Univ. of Manchester, Eng.). Science, 147: 1571(Mar. 26, 1965).

Nitrous oxide at low concentrations reduced the high yield of hydrogen from γ-irradiated water vapor containing methanol from 8.9 per 100 electron volts absorbed to a plateau value of 5.9. This indicated that both electrons (yield 3.0) and hydrogen atoms (yield 5.4) are precursors to the hydrogen, the former being scavenged by nitrous oxide. (auth)

22377 γ-RAY IRRADIATION EFFECTS ON PORPHYRIN COMPOUND. A GEOCHEMICAL STUDY RELATES TO THE ORIGIN OF PETROLEUM. Shuji Kudo and Hisaichi Iwamoto (Japan Petroleum Exploration Co., Ltd.). Sekiyu Gijutsu Kyokaishi, 29: 262-7(Nov. 1964). (In Japanese)

In studies of radiation effects on the origin of petroleum, the sodium salt of copper chlorophyrin, which is a primary derivative of chlorophyll (a source material of petroleum), was irradiated with gamma radiation. The results are discussed from a geochemical point of view. Decomposition of the salt was the first-order reaction of the radiation dose. A portion of sodium salt of copper chlorophyrin transferred to pheoporphyrin, pheocrythrin, and a similar compound of chlorin. Gaseous products consisting of hydrogen, methane, ethylene, ethane, propane, and carbon dioxide were obtained. The presence of rocks and water had an influence on radiolysis, and the effects were more pronounced than those obtained during irradiation in bulk. From these experimental results, it is suggested that natural radioactivity from minerals in sedimentary rocks might play an important role for the formation of petroleum. (auth)

22378 KINETICS OF THE RADIOCHEMICAL GRAFT COPOLYMERIZATION OF ACRYLONITRILE WITH CAPRON FIBER. K. A. Kornev, A. A. Kachan, L. L. Chervyatsova, L. S. Polak, E. F. Mertivichenko, and S. S. Demchenko (High Polymer Inst., Academy of Sciences, SSSR). Ukr. Khim. Zh., 30: 1318-21(1964). (In Russian)

Degreased, drawn, capron fiber was irradiated (^{60}Co source, 1600 C, 100 rad/sec, 10^{-3} mm Hg, room temperature, 0.25 Mrad) and exposed to an acrylonitrile vapor at 80 mm pressure in a study of the kinetics of vapor seeding graft copolymerization, which does not involve formation of a homopolymer. Graphs are presented, which illustrate the effects of temperature (22 to 60°C, 0 to 24 hr), radiation dosage 0 to 20 Mrad), and monomer vapor pressure (30 80 mm Hg, 0 to 10 hr). Constants were calculated for the rate of chain growth, rate of chain disruption, the apparent activation energy (1.9 kcal/mol), activation energy of chain growth and chain disruption, the average distance between initiation centers (120 Å), and the average lengths of chains. An increase in monomer vapor pressure led to an increase in the quantity of copolymerized polyacrylonitrile. An increase in temperature decreased the amount of copolymerization, while an increase in radiation dosage above 2 Mrad had little effect. (ATD)

22379 ON THE KINETICS OF GENERATION OF F-CENTERS IN NaCl WHISKERS. S. U. Gol'denberg and I. Ya. Melik-Gaikazyan (Tomsk Polytechnic Inst., Kirov, USSR). Soviet Phys.-Solid State (English Transl.), 6: 2790-1(May 1965). Translated from Fiz. Tverd. Tela, 6: 3484-6(Nov. 1964).

NaCl whiskers were grown through a porous partition from an aqueous solution and from the gaseous phase. The samples were irradiated with unfiltered x rays and the generation of F centers was investigated as a function of time. For samples with a high density of dislocations, the F-center growth curves were found to be of the same kind as growth curves of NaCl single crystals. Dislocation-free samples grown from the gaseous phase were found to have different F-center generation kinetics, with saturation in the second stage. The presence of a linear region in the growth curves supports the conclusion that radiation may generate vacancies in a perfect crystal lattice, this generation being accompanied by the formation of Frenkel defects. (L.B.S.)

22380 ON THE UV-IRRADIATION OF DESOXYRIBONUCLEIC ACID IN GLYCOL. Hanswerner Dellweg and Adolf Wacker (Universitat, Frankfurt am Main). Z. Naturforsch., 20b: 141-3(Feb. 1965). (In German)

Glycol causes denaturation of the DNA double helix structure in solution. As was previously shown, heat denaturation of DNA leads to an increased dimerization of thymine following uv irradiation. In contrast to this, thymine dimer is not increased, but is slightly decreased, when DNA is irradiated by ultraviolet light in the presence of glycol. These results are discussed with regard to the distortion of the hydration layer and the hydrophobic stacking of bases, as influenced by glycol. (auth)

22381 MEASUREMENT OF THE PHOTOELECTRIC CONDUCTIVITY IN ANTHRACENE CRYSTALS. Claus Bogus (Universitat, Giessen, Ger.). Z. Physik, 184: 219-28(1965). (In German)

The drift mobility of holes in pure anthracene was measured by the transient photoconductivity technique used by KEPLER and LeBLANC. The mobility is 0.8 cm^2/vsec and varies as T^{-2}. In tetracene-doped crystals the drift-mobility of holes decreases with growing Tetracene concentration and it varies exponentially as $-T^{-1}$, which suggests that Tetracene acts as a trap. The trap depth is 0.45 ev. By pre-irradiation with alpha particles or x rays, the photocurrent is reduced; and it is supposed that alpha irradiation produces deep traps, whereas x rays produce shallow traps as well. (auth)

22382 ELECTRON SPIN RESONANCE STUDIES OF BORATE GLASSES IRRADIATED WITH GAMMA-RAYS. Yasuo Nakai (Tokyo Shibaura Electric Co., Ltd.). Z. Physik. Chem (Frankfurt), 44: 45-56(Jan. 1965).

Electron spin resonance spectra were observed for wet borate glasses exposed to γ irradiations. The irradiated wet borate glasses exhibited spectra consisting of five peaks, which arose from a hyperfine interaction with a ^{11}B nucleus and a doublet with a 504-gauss separation at operating microwave frequencies in the vicinity of 9.4 kMc/sec. The doublet splitting seemed to arise from a free hydrogen atom in the center of an interstitial vacancy produced by the radiolysis of B–O–H–O–B in the glass. A similar result was found with deuterated borate glass, where the resonance spectrum consisted of a triplet with a 154-gauss separation. The mechanism of the formation of the hydrogen center (P_H) is discussed. (auth)

22383 ON THE γ-RADIOLYSIS OF LIQUID AND SOLID AMMONIA. D. Schischkoff and D. Schulte-Frohlinde (Kernforschungszentrum, Karlsruhe, Ger.). Z. Physik. Chem. (Frankfurt), 44: 112-21(Jan. 1965). (In German)

In the ^{60}Co γ-radiolysis of ammonia, hydrogen, nitrogen, and hydrazine were formed. The G values of the products were determined for various doses and in the presence of various additives at 25 and −196°C. In the liquid state of G values of the products changed with dose up to a stationary hydrazine concentration. In solid form, however, the G values were independent of dose, and no stationary hydrazine concentration appeared. An addition of isopropanol in liquid ammonia lowered the G value of nitrogen and increased that of hydrazine. However, in solid ammonia isopropanol had no influence on the G values of nitrogen and hydrazine formation. The significance of the results for the formation and decomposition of hydrazine are discussed (tr-auth)

22384 SOME CHANGES IN EPR SPECTRA OF IRRADIATED POLYISOBUTYLENE. E. N. Teleshov, V. A.

Sharpatyi, A. N. Pravednikov, and S. S. Medvedev (Karpov Inst. of Physical Chemistry, Moscow). Zh. Strukt. Khim., 5: 627-9(1964).

The irradiation of polyisobutylene (PIB) at liquid nitrogen temperature led to accumulation of free radicals in it. The EPR spectrum of these radicals was a doublet with approximately 22 Oe splitting, which was attributed to the $-C(CH_3)_2-CH-C(CH_3)_2$ radical. An attempt was made to obtain, by the EPR method, some additional information on the nature and properties of radical products formed during radiolysis of PIB. It was found that heating of PIB samples, irradiated with $\sim 10^{22}$ ev/g dose of 1.6-Mev electrons at -180°C leads, along with the destruction of primary radicals, to irreversible changes in EPR spectrum. In it the doublet is converted to a spectrum, which consists of seven basic lines with addition of fine structure. This spectrum may be ascribed to the radical produced by addition of an isobutylene molecule to the radical $-C(CH_3)_2-CH-C(CH_3)_2$. Isobutylene is produced during radiolysis of PIB. During low-temperature radiolysis of PIB the second radical is not detectable by the EPR method because radicals formed during breakage of the radical chain immediately enter recombination and disproportionation reactions. Irradiation of PIB at -600°C (above vitrification temperature of the polymer) with simultaneous registration of EPR spectra enables both radicals to be found. PIB irradiated with uv at -60°C for 5 min produced EPR spectrum similar to that of a mixture of PIB and isobutylene irradiated with electrons. It is suggested that under the influence of uv, isomerization of primary radicals may take place. (CFSTI)

22385 RADIOBIOLOGICAL REACTIONS AT THE SUBCELLULAR LEVEL. Z. Zseboek (Medical Univ., Budapest). p.9-11 of "Report of the Symposium on Radiosensitivity." Quebec, Laval Medical, Inc., 1963.

Results are reviewed from studies on the radiolysis of water and the chemical effects produced by ionizing radiations on nucleic acids in aqueous solutions. It is pointed out that experimental results show that radiation effects include deamination, dehydroxylation, rupture of hydrogen bonds, fission of sugar-base linkage, liberation of purine bases, break-down of pyrimidin bases, oxidation of the sugar moiety, breakage of the nucleotide chain, and liberation of inorganic phosphates. These results indicate that irradiation breaks down the nucleic acid molecule. It is pointed out that this is only a preliminary conclusion and many essential points need clarification. (C.H.)

22386 PERSISTENT INTERNAL POLARIZATION INDUCED IN ORGANIC SOLID BY RADIATION. Sohachiro Hayakawa and Keiichi Ohno (Tokyo Inst. of Tech.). Session II, Paper 5 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

It was found that persistent internal polarization (PIP) induced by gamma rays in powdered anthracene dispersed in silicon resin could be used for radiation dosimetry. A dose rate of 20 mr/min from ^{60}Co was used. (M.C.G.)

22387 TABLES OF CONSTANTS AND NUMERICAL DATA AFFILIATED TO THE INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY. 13. SELECTED CONSTANTS, RADIOLYTIC YIELDS. R. Bensasson, A. Bernas, M. Bodard, et al. New York-Paris, Pergamon Press, 1961. 217p.

The values of radiolytic yields compiled cover quantitative research on chemical effects of ionizing radiation from 1905 to Jan. 1, 1961. The yields are expressed in terms of G. The results are presented in two tables, for organic and inorganic compounds. The radiations used, medium conditions, radiolytic yields, remarks, and bioliographic references are given. A list of bibliographical references, author's index, an alphabetical index of substances mentioned, and a formula index are included. (M.C.G.)

22388 SENSITIZATION OF CHEMICAL AND PHOTOCONDUCTIVE PROCESSES BY THE FLUORESCEIN DYE TRIPLET STATES. Leonard I. Grossweiner (Illinois Inst. of Tech., Chicago). p.287-307 of "Physical Processes in Radiation Biology." New York, Academic Press, Inc., 1964.

A review is presented on photochemical reactions in solution sensitized by the fluorescein dyes, with emphasis on experimental results that identify the intermediate species. The photooxidation of aqueous phenol is discussed as a specific example of how flash photolytic and continuous irradiation measurements can give information on the mechanism and reaction kinetics of the elementary processes. New results on the sensitization of photoconductivity in a semiconducting substrate are summarized with an analysis of the process based to some extent on the chemical properties of the dye. Most of the discussion is confined to eosin. (P.C.H.)

22389 INFLUENCE OF RADIOCHEMICAL CROSSLINKING OF ELASTOMERS ON THEIR ADHESION TO FIBERFORMING POLYMERS. V. G. Raevskii, E. V. Egorov, V. E. Mikhlin, V. E. Gul', and S. S. Voyutskii. p.89-93 of "Sbornik Vysokomolekul. Soyedineniya. Adgeziya Polimerov." Moscow, Academy of Sciences, 1963.

The change of durability of adhesion of elastomers SKS-30 ARM-15, SKN-26, and butyl rubber with polycaprolactam film during irradiation of samples by a flow of accelerated electrons was examined. It was determined that the change of resistance to separation during irradiation is described by curves passing through a maximum which corresponds to a definite integral dose of irradiation. Thus the character of the change in adhesion strength during radiation vulcanization does not differ qualitatively from that observed previously for cases of thermal vulcanization in the presence of vulcanizing agents. For samples with coatings of SKS-30 ARM-15 the dependence of the adhesion of this elastomer to polycaprolactam film was studied from the degree of its crosslinking during irradiation. The latter was characterized by the length of the section of molecular chain (M_c), included between two nodes of the space lattice. It was found that the limiting degree of crosslinking, after the achievement of which a drop of adhesion strength sets in, shifts under the influence of radiation in the direction of a smaller density of the lattice, as compared to that observed for thermal vulcanization in the presence of vulcanizing agents. This phenomenon is explained from the positions of diffusion theory of adhesion. The presence of a limiting degree of crosslinking during radiation vulcanization was observed also on rubber-fabric materials based on capron fabric with a coating of Nairit and SKS-30 ARM-15 applied by facing the fabric on a calender. (CFSTI)

22390 RADIATION INDUCED ELECTRICAL PROPERTY CHANGES IN POLYMERIC SOLIDS. S. E. Harrison and E. A. Szymkowiak (Martin Co., Baltimore). 10p. (CONF-720-17)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Significant changes were measured in the electrical properties of organic insulating solids as a function of nuclear radiation. The electrical properties selected for discussion include dissipation factor and conductivity. The dissipation factor changed by orders of magnitude as a function of dose. These changes, as a function of dose, were dependent on temperature, pressure, ambient gas composition, and dose rate. Conductivity was particularly sensitive to dose rate, and the decay of photon-induced conductivity changes was considered to be controlled by a trapping process. The significance or lack of significance of the nuclear radiation-induced changes in dissipation factor, conductivity, and other electrical properties of interest for organic insulating solids is very much dependent upon application. For example, for low rate, long duration exposures dissipation factor changes are most significant, and for high dose rate, short duration exposures conductivity changes are most significant. (auth)

22391 IRRADIATION "FACTOR-INTERDEPENDENCY" AS EVIDENCED BY STATISTICAL EVALUATION OF DATA FOR ACRYLONITRILE. Ed. F. Degering, Gerald J. Caldarella, and George H. Haines, Jr. (Army Natick Labs., Mass.). 17p. (CONF-556-23)

From 12th Annual Meeting of the Radiation Research Society, Miami, Fla., May 1964.

Experiments of a factorial type were used to evaluate the effects of degassing the acrylonitrite sample, flame-out of the reaction tubes at 5μ or less, increment of dose per exposure, and the irradiation cycle or the time interval between successive exposures to accelerated electrons. Polymer formation was determined by direct weighing of the nonvolatile portion of each sample. It was concluded that degassing, dose increment, and irradiation cycle are all significant variables. Both degassing and irradiation cycle and dose increment and irradiation cycle were interdependent (or first order) significant interactions. Degassing, dose increment, and irradiation or time cycle was a three-factor interdependent (or second order) significant interaction. (M.C.G.)

22392 PROCESS FOR IMPROVING THE PROPERTIES OF SYNTHETIC FIBRES, FABRICS, FILMS AND MOULDED ARTICLES BY IRRADIATION WITH RADIOACTIVE RAYS. Tadashi Muroi, Shunji Onishi, Satoshi Morimoto, and Aizo Yamauchi (to Agency of Industrial Science and Tech.). U. S. Patent 3,154,479. Oct. 27, 1964. Priority date Apr. 28, 1958, Japan.

The dyeability and hygroscopicity of synthetic fibers, fabrics, films, and molded objects can be improved by irradiating the articles with high-energy ionizing radiation to a total dosage of about 10^4 to 10^6 R. The irradiation is carried out in the presence of a monomer or the articles are heated with the monomer after irradiation. The monomer is a three-membered heterocyclic compound, two of whose members are simple alkyl radicals and whose third member is an oxygen atom, sulfur atom, or N—R′ radical where R′ is a hydrogen atom or alkyl radical. (A.G.W.)

22393 DEMETALLIZATION OF HEAVY PETROLEUM OILS. Robert B. Long and Peter J. Lucchesi (to Esso Research and Engineering Co.). U. S. Patent 3,154,480. Oct. 27, 1964. Filed Aug. 22, 1957.

A process for removing metallic impurities from petroleum residua (boiling range 900-1500°F) by reducing the porphyrin-metal complex content and simultaneously cracking the residua to lower boiling petroleum products (boiling point <430°F) consists of subjecting the residua mixed with a subdivided absorbent hydrocarbon conversion catalyst such as silica-alumina to high-energy ionizing radiation in a nuclear reactor. The radiation is equivalent to a total dosage in the range of 10^{17} to 10^{25} ev/g. The irradiation is carried out at a temperature of 200-600°F with a volume ratio of catalyst to residua of 1:10 to 2:1, and the catalyst has a surface area of ~50 to 600 m^2/g. After either continual or batchwise irradiation, the petroleum residua is separated by conventional methods from the catalyst containing a portion of the metallic impurities absorbed on it. (A.G.W.)

22394 POLYMERIZATION OF ISOBUTYLENE. Max S. Matheson (to U. S. Atomic Energy Commission). U. S. Patent 3,174,921. Mar. 23, 1965.

A method was developed for polymerizing isobutylene. A mixture of equal parts of isobutylene and isopentane were irradiated in a vacuum with ultraviolet light, which had a wave length lower than 1600 Å at a temperature between −150 and −160°C. (AEC)

Radiochemistry

See also Separation Processes and Procedures.

22395 HOT-ATOM CHEMISTRY OF RADIOCOBALT IN OXALATOCOBALT(III) COMPLEX SALTS. Nobufusa Saito, Hirotoshi Sano, and Takeshi Tominaga (Tokyo Univ.). Chem. Ind. (London), No. 38, 1622-3 (Sept. 1964).

The effects of the oxalate ion content on the retention value in several cobalt complex salts were examined. The following crystalline salts were studied: $K_3[Co(C_2O_4)_3]3H_2O$, $(NH_4)_3[Co(C_2O_4)_3]3H_2O$, $NH_4[Co(C_2O_4)_2(NH_3)_2]2H_2O$, $[Co(C_2O_4)(NH_3)_4]NO_3.H_2O$, and $[Co(NH_3)_6]_2(C_2O_4)_3.4H_2O$. They were irradiated in the JRR-1 reactor for one hour at reactor temperature in the presence of air, at a thermal neutron flux of 3×10^{11} n/cm² sec. The irradiated salts were dissolved in water and the ^{60}Co-labeled species were separated by procedures involving paper electrophoresis, ion exchange, or solvent extraction, but the distribution of ^{60}Co activity was practically the same irrespective of the method employed. The results showed that there were only two species containing ^{60}Co atoms, corresponding to the cationic divalent Co species and the parent complex species. The results also showed that the yield of cationic divalent radiocobalt was more than 90% in each case. The respective yields of cationic Co(II) species for the five irradiated complex salts were: 98.6, 98.7, 96.0, and 91.0%; and of the parent complex species 1.4, 3.5, 1.3, 4.0, and 9.0%. The retention value obtained from the $^{59}Co(n,\gamma)^{60}Co$ reaction, in potassium tris-oxalatocobaltate(III), was close to that from the $^{59}Co(\gamma,n)^{58}Co$ reaction reported previously. (BBB)

22396 RECENT PROGRESS IN RADIOACTIVE CHEMICAL MANUFACTURE. W. P. Grove (Radiochemical Center, Amersham, Eng.). Chem. Ind. (London), No. 3, 128-34 (Jan. 16, 1965).

Developments in radiochemical production over the past 10 years are emphasized. In this period there has been no outstanding discovery or fundamental development that has radically altered the approach to radiochemical manufacture, but much technical progress has been made toward a wider variety of products, which are obtainable in larger radioactive quantity, and of higher quality. The processes of making radioactive chemicals are discussed in terms of three stages: creation of the required radioisotope by a nuclear transformation; separation of the isotope from the irradiated target material, usually by chemical refining, and synthesis of the final chemical product by chemical or biological means. Choice of target materials is considered as an important factor in successful isotope production. Nuclear reactions and materials used in obtaining certain isotopes are given, with reference to specific examples of processes employed at Amersham where increasing use is being made of the cyclotron, and 30 radioisotopes are now derived routinely from this source. Chemical and physical refining processes are described, again with reference to specific examples, for obtaining purified isotopes. Labeling methods are outlined, with special reference to ^{3}H and ^{14}C compounds. The problem of stability of labeled compounds is considered. Apart from the radioactive decay, which is unavoidable, radiolytic decomposition may produce impurities that are usually significant after storage for a few months, and in special cases after a few days or even hours. The basic causes of this decomposition by self-irradiation are enumerated. It was concluded that today the supply of radioactive chemicals is running ahead of the demand. (TCO)

22397 HEAVY ATOM LABELLING OF THE SERINE OF THE ACTIVE CENTER OF CHYMOTRYPSIN: PIPSYL-CHYMOTRYPSIN. J. Kallos and D. Rizok (St. Mary's Memorial Hospital, Montreal). J. Mol. Biol., 9: 255-9 (1964).

The introduction of a heavy atom derivative of the active site of chymotrypsin (CHT) was attempted to facilitate x-ray diffraction studies by providing a marker which would locate the active center crystallographically. Treatment of CHT with p-toluenesulfonyl (tosyl) chloride or fluoride was followed by the isolation and crystallization of the resulting Ts-CHT. Another study consisted of treating CHT with a heavy atom inhibitor, namely, p-iodobenzenesulfonyl (pipsyl) chloride as a method of introducing a single heavy atom, iodine, into the active site of CHT. The preparation and crystallization of the heavy atom labeled pipsyl-CHT, and direct chemical evidence that the pipsylation and tosylation reactions occur at the serine residue of the active center, are described. The reaction was carried out as follows: CHT (50 μmoles) dissolved in phosphate buffer (pH 7.8) at 0°C, was treated with two portions of pipsyl chloride (35 μmoles) in ice-cold acetonitrile added successively at 20-min intervals. Final acetonitrile

concentration in the reaction mixture was 10%. After one hour, the reaction mixture was extensively dialysed at 4°C against 10^{-4}M HCl. The pipsyl-CHT was isolated by freeze-drying. Enzyme assay showed the pipsyl-CHT to be 97 to 98% inhibited. To establish the exact molar ratio of iodine, ^{125}I-pipsyl-CHT was prepared in the same manner as the nonradioactive pipsyl-CHT, using ^{125}I-pipsyl chloride. The specific activity of ^{125}I was measured on a gas-flow counter. Radioassay showed the presence of 1.06 atoms of iodine per molecule of ^{125}I-pipsyl-CHT. These results demonstrate the irreversible loss of enzymic activity resulting from the stoichiometric interaction of pipsyl chloride and CHT, and thus strongly suggest that the pipsyl group is linked by a covalent bond to the active site of CHT. The isolation and identification of pyruvic acid as its crystalline 2,4-dinitrophenylhydrazone constitutes direct evidence that the tosylation and pipsylation reactions occur at the active serine residue. (BBB)

22398 DETERMINATION OF RADIOIODIDE CONTAMINATION OF RADIO-HIPPURAN AND OTHER RADIOIODINATED ORGANIC SALTS. T. A. Hosick, F. C. Watts, and I. Meschan (Bowman Gray School of Medicine, Wake Forest Coll., Winston-Salem, N. C.). J. Nucl. Med., 6: 136-41(1965).

A simple technique for the estimation of ^{131}I contamination in water-soluble, carbon tetrachloride-insoluble, radioiodinated organic compounds is described. Aqueous samples are treated by swirling for one hour with a layer of carbon tetrachloride saturated with nonradioactive elemental iodine. The disproportionation of the original radioactivity between the aqueous and I_2-CCl_4 layers after equilibrium is determined, and the per cent of radioactivity originally present as radioiodide is calculated therefrom. The activity originally present as radioiodide transfers into the I_2-CCl_4 layer, leaving the radio-organic compound in the aqueous layer. (auth)

22399 FALLOUT PARTICLES. PART II. Tetsuo Mamuro (Radiation Center of Osaka Prefecture). Mizushori Gijutsu, 5: No. 3, 15-19(Mar. 1964). (In Japanese)

The solubility of fallout particles is first discussed. Fallout particles do not completely dissolve in 6N HCl, aqua regia, or aqueous ammonia. However, they dissolve completely in water after fusion with Na_2CO_3 or $NaHSO_4$. Next, the fractionation effect is discussed. In one example the highly radioactive fallout particles contained more ^{95}Zr + ^{95}Nb and less ^{103}Ru than the fine fallout particles. Measurements of highly radioactive fallout particles gave fractionation factors of 0 for ^{103}Ru, 0.1 – 0.9 for ^{141}Ce + ^{144}Ce, 0.02 – 0.1 for ^{140}Ba + ^{140}La, 0.1 – >1 for ^{99}Mo, 0.55 for ^{90}Sr, and 0.01 for ^{89}Sr. The fractionation factor is defined according to K. Edvarson et al. (1959). Finally, the results of x-ray microanalysis of highly radioactive fallout particles are given. The color of the particles is related to the contents of Fe and Al. (NSA of Japan)

22400 THE CORRELATION BETWEEN THE ACTIVITY AND THE EXTERNAL EMISSION OF EXTENDED ^{90}Sr+ ^{90}Y β EMITTERS. A. A. Konstantinov and V. V. Perepelkin. p.8-11 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

The activity of ^{90}Sr + ^{90}Y β emitters was examined on the basis of their external radiation and the coefficient R, the ratio of the activity of a large β emitter and its external emission. The coefficient R was determined by measuring the thickness of the active layer, the reflection of the β particles from the support and absorption in the shielding foil and in the filter paper. The spectrum measurements of the specimen were compared with those of a reference unit, using a 4π counter. (TTT)

22401 WORKING STANDARDS AND COBALT-60 FIRST-ORDER DISCHARGE REFERENCE γ EMITTERS. A. F. Drichko, F. M. Karavaev, L. P. Kul'kova, and E. A. Khol'nova. p.11-13 of "Novye Naucho-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

The standards were fabricated from metallic Co in the form of 2.00 ± 0.04-mm diameter and 2.0 ± 0.1-mm high cylinders encapsulated in Al. By 1963 6 series of emitters were completed, each containing 8 individual sources with activities ranging from 0.5 to 400 μC. In view of the relatively short half life of ^{60}Co, the lowest-intensity sources were gradually removed from the list of available working standards. The certified sources were destined to be transmitted to the various research institutes and the Bureau of Standards and to departmental laboratories. (TTT)

22402 CALCULATION OF THE EMISSION SPECTRUM OF COBALT-60 AND CESIUM-137 EMITTERS. K. K. Aglinstev. p.24-7 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

Calculations were carried out to determine the intensity and the spectral composition of scattered radiation of small, spherical ^{60}Co and ^{137}Cs emitters. The method of the theoretical determination of the primary radiation yield was based on the assumption that in the case of small sources, the experimental absorption values are practically identical with the calculated ones. The spectral composition was determined from the Klein-Nishina-Tamm formula; the scattered γ quanta were distributed over a broad range from 210 kev to 1.33 Mev for ^{60}Co and from 185 to 661 kev for ^{137}Cs. The spectral composition of the radiation scattered by the collimator was found to differ only very slightly from the primary radiation. (TTT)

22403 RADIOACTIVE SOURCE COMPRISING A POLYAMIDOXIME OR A POLYHYDROXAMIC ACID COMPLEXED WITH A RADIOACTIVE METAL. Charles A. Fetscher (to Nopco Chemical Co.). U. S. Patent 3,154,499. Oct. 27, 1964. Filed Jan. 23, 1961.

A radioactive source is prepared by contacting a solid chelating agent with a solution of one or a mixture of radioactive isotopes either batchwise or continually. The chelating agent is a high-molecular-weight polymer containing either amidoxime or hydroxamic acid substituents, and the radioactive metal is selected from the group consisting of ^{59}Fe, ^{60}Co, ^{107}Pd, ^{195}Au, ^{232}Th, ^{239}Pu, ^{233}U, and ^{235}U. Nitrile type cross-linked polymers are also applicable. After chelation the source contains an amount from a trace up to 50 wt% of the polyamidoxime or polyhydroxamic acid. The high-molecular-weight polymers can be formed into powders, fibers, woven or unwoven fabrics, or other forms before being chelated with the radioactive material. Sources so prepared can be used for such processes as sterilization, reactions between chemicals, and treatment of humans. (A.G.W.)

Separation Processes and Procedures

See also Analytical Procedures.

Refer also to abstracts 22104, 22870, 23991, and 24064.

22404 (HW-65531) INFORMATION FOR APPLICATION ON IN-TANK BORON MONITORS. J. D. Lodge (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). June 10, 1960. Contract AT(45-1)-1350. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Monitors were developed for measuring the boron concentration in chemical process tanks. The monitors include a neutron source, a slow neutron detector, a preamplifier, and a housing unit. Instrument components and calibration curves are presented for the monitors for the makeup tank, head tank, and evaporators in the Redox plant. (D.L.C.)

22405 (HW-83298(p.4.1-25)) CHEMICAL RESEARCH AND DEVELOPMENT. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

In salt cycle development, results of analysis for three electrolytic separation runs with irradiated fuels are dis-

cussed. In radioactive residue process development, a spray-calcination run was made with Purex waste to establish Ru sampling accuracy counting results showed that the membrane filters used were efficient Ru samplers. In other work with wastes, the properties of glass-fixed residues, effects of composition on waste properties, cold semiworks, spray-calciners, calciner powder melters, calciner pot materials, waste solidification stability of BAMBP (4-sec-butyl-2-α-methylbenzylphenol) in CSREX solvent, in-tank solidification, and intermediate level waste treatment, were considered. Work on reactor containment experiments to evaluate the effectiveness of natural processes and engineered safeguards in limiting release to the environs of fission products is reported. Data are included on the retention of elemental I_2 and particles on May pack collectors. (J.R.D.)

22406 (ORNL-TM-1096) BURN-LEACH PROCESSES FOR GRAPHITE-BASE REACTOR FUELS CONTAINING CARBON-COATED CARBIDE OR OXIDE PARTICLES. E. L. Nicholson, L. M. Ferris, and J. T. Roberts (Oak Ridge National Lab., Tenn.). Apr. 2, 1965. Contract [W-7405-eng-26]. 26p. (CONF-650606-1). Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

From EURATOM Symposium on Fuel Cycles of High-Temperature Gas-Cooled Reactors, Brussels.

Processing of graphite-base high-temperature gas-cooled reactor fuels containing carbon-coated carbide or oxide particles is discussed. The most promising process consists of burning of the fuel in a fluidized-bed of inert alumina followed by leaching of the product bed with Thorex reagent to recover the uranium and thorium. Decontamination and final recovery of the uranium and thorium would be achieved by conventional solvent extraction methods. A preliminary engineering evaluation and potential costs are included. (auth)

22407 (RFP-442) RECOVERY AND PRELIMINARY PURIFICATION OF AMERICIUM OBTAINED FROM WASTE MATERIAL. P. G. Hagan and H. W. Miller (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Mar. 29, 1965. Contract AT(29-1)-1106. 11p. Dep.; $1.00(cy), 1(mn) CFSTI.

Americium was recovered from miscellaneous residues by leaching with hot concentrated hydrochloric acid. The solution was filtered, diluted to about 5% acidity, and precipitated as an oxalate. The oxalate was then calcined to americium oxide. Since the oxide contained a considerable amount of lead, calcium, cerium, potassium, and plutonium, further purification was necessary. The method employed utilized both simple cation-anion ion exchange and precipitation techniques. Ammonium thiocyanate was used as both an eluting and a complexing agent. The americium oxide content of the product was increased from approximately 42 to 99%. (auth)

22408 SEPARATION AND DETERMINATION OF RARE EARTH METALS BY ION EXCHANGE CHROMATOGRAPHY. II. CHROMATOGRAPHIC SEPARATION OF RARE EARTHS COMBINED WITH CHEMICAL DETECTION. Janos Inczedy, Gabor Nemeshegyi, and Laszlo Erdey (Technical Univ., Budapest). Acta Chim. Acad. Sci. Hung., 43: 9-15 (1965).

An ion exchange chromatographic method was developed for the separation and determination of rare earths. A photometric procedure serves for quantitative evaluation. Separation is carried out by a cation exchange column using an ammonium lactate-lactic acid buffer with gradient elution. The determination of rare earths in the collected fractions can be carried out by a direct photometric method. The colorimetric reagent contains copper(II) ions, EDTA, and PAN. (auth)

22409 EXTRACTION OF ^{95}(Zr,Nb) FROM OXALIC ACID SOLUTIONS BY MEANS OF TRI-ISO-OCTYL AMINE. M. V. Susic and Z. B. Maksimovic. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 135-41(July 1963).

The extractibility of ^{95}(Zr,Nb) with tri-iso-octylamine in xylene from an oxalic acid solution was investigated. The behavior of uranium and other fission products was also observed. The extraction of ^{95}(Zr,Nb) was studied as a function of oxalic acid and amine concentrations. Effects of the aqueous phase pH, uranium, and the presence of other electrolytes were also observed and the possibility of separating ^{95}(Zr,Nb) from uranium and from other fission products considered. (auth)

22410 CATION EXCHANGE SEPARATION OF URANIUM FROM OTHER METALS: SELECTIVE ELUTION WITH PHOSPHORIC ACID. N. P. K. Krishnan and T. K. S. Murthy (Atomic Energy Establishment, Trombay, India). Indian J. Pure Appl. Phys., 3: 105-7(Mar. 1965).

The use of phosphoric acid as a selective eluant for uranium from a cation exchange resin in the H^+ form was investigated. For comparison, elution studies with other acidic eluants, such as perchloric, nitric, hydrochloric and sulfuric acids were also carried out. Phosphoric acid, because of its relatively high complexing ability, was found to be an efficient eluant for uranium. Successful quantitative separation of uranium from its mixture with a number of bivalent and a few trivalent ions was effected, using 1.0M phosphoric acid as the eluant. (auth)

22411 ANION EXCHANGE FRACTIONATION OF LIGHT LANTHANONS. S. K. Kundra, S. A. Shah, P. R. Subbaraman, and J. Gupta (National Chemical Lab., Poona, India). Indian J. Pure Appl. Phys., 3: 108-10(Mar. 1965).

Separation of the Sm–Nd pair on an anion exchanger was found to be more effective when elution was carried out with a weak complexing agent rather than with a non-complexing eluant. Sm–Nd and Nd–Pr pairs were fractionated by impregnating their nitrilotriacetato and triphosphato complexes on an ion exchange resin and eluting with citric acid. The anion exchange method was more useful in this separation because of the excess of the less basic constituent in the pair. Once the minor constituent was eluted out, the major constituent was collected by leaching the column with hydrochloric acid. (auth)

22412 ON THE POSSIBILITY OF USING SOILS FOR THE PURIFICATION OF LOW RADIOACTIVITY SEWER WATERS. I. ADSORPTION OF Co^{60} BY THE SOIL OF PEAT BOGS. A. I. Berdnikov and V. F. Oreshko (Moscow Medical Inst.). Izv. Vysshikh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 7: 594-7(1964). (In Russian)

The adsorption by peak soils of ^{60}Co from aqueous solutions was investigated as a function of the nature, degree of decomposition, granulometric composition, concentration of the radioisotope, and pH of the medium. It was found that peat soils readily adsorb ^{60}Co from solution. The maximum rate of sorption was possessed by hypnum and wood-floodplain samples with low (10%) and medium (50%) degrees of decomposition. The radioactivity level of the solution exerted practically no influence on the sorption process. The maximum adsorption fell within the range of pH values from 5.0 to 8.0. The possibility of complexing ^{60}Co with the primary and secondary amino groups of peat, as well as with the sulfo groups in hydrochloric acid medium and with hydroxycarboxylic acids in alkaline medium is suggested as an explanation of the observed pattern of sorption. Peat soils are recommended as cheap natural absorbents in the purification of waters with low radioactivity. (CFSTI)

22413 CONCENTRATION OF THE FLUOROZIRCONATE ION BY ION FLOTATION. N. W. Rice and F. Sebba (Univ. of Witwatersrand, Johannesburg). J. Appl. Chem. (London), 15: 105-9(Mar. 1965).

The conditions for concentrating the fluorozirconate ion (ZrF_5^{3-}) by ion flotation with amine salts as collector were studied. The effect of changed bubble rate, concentration of collector, and zirconium-fluoride ratios, as well as change of pH, were examined. Collection into a solvent was also studied. Maximum recovery was 80%. (auth)

22414 RADIOCHEMICAL SEPARATION OF TIN AND ANTIMONY BY AN INITIAL PHOSPHATE PRECIPITATION STEP. M. P. Menon, N. K. Aras, and J. W. Irvine,

Jr. (Massachusetts Inst. of Tech., Cambridge). J. Inorg. Nucl. Chem., 27: 767-71(Apr. 1965).

A procedure for the separation of tin and antimony from fission product mixtures, using the difference in the precipitation behavior of tin and antimony phosphates, is presented. Although the radiochemical purification of tin is performed by procedures similar to those reported in the literature, antimony is essentially purified by the stibine method, using $NaBH_4$ as a reducing agent for the stibine generation. Chemical yields of 60 to 70% were obtained for both tin and antimony, and the decontamination factors were, in general, of the order of 10^3. (auth)

22415 EXTRACTION OF URANIUM(IV) NITRATE BY TRI-N-BUTYL PHOSPHATE AND BY DIBUTYL CARBITOL. H. A. C. McKay and R. J. W. Streeton (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 27: 879-84(Apr. 1965).

Uranium(IV) nitrate is readily extractable from aqueous nitric acid solutions by both tri-n-butyl phosphate (TBP) in an inert diluent and dibutyl carbitol, though less so than neptunium(IV) and plutonium(IV) nitrates. In the former solvent it appears to form a di-solvate, $U(NO_3)_4 \cdot 2TBP$. The possible role of the hexanitrato form, $H_2U(NO_3^-)_6$, is discussed. (auth)

22416 ZEOLITE TYPE X EQUILIBRIA WITH TRIVALENT CERIUM AND YTTRIUM CATIONS. L. L. Ames, Jr. (General Electric Co., Richland, Wash.). J. Inorg. Nucl. Chem., 27: 885-94(Apr. 1965).

Studies were made to determine quantitatively, equilibria in Y and rare earth-containing systems with Linde 13X zeolite. Isotherms were obtained for Na–Ce, Na–Sr, Na–Y, and Sr–Ce systems. Cation exchange equilibrium was approached from both directions in the Na–Ce system. Thermodynamic data derived from the isotherms are tabulated. Several generalities concerning the type X isotherms were noted. All isotherms containing a trivalent cation show a selectivity reversal. A preference of type X for the larger diameter cation, all other things being equal could be predicted from other equilibrium results. Initially the zeolite would prefer the larger cation. (P.C.H.)

22417 SEPARATION OF $^{141,144}Ce$, ^{91}Y, AND ^{95}Zr–^{95}Nb FROM FISSION PRODUCTS BY TRI-N-BUTYLPHOSPHATE. Tomitaro Ishimori and Yoshii Kobayashi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 108-11(Mar. 1965).

Separation of fission products was carried out by solvent extraction using tri-n-butyl phosphate (TBP). $^{141,144}Ce$, ^{91}Y, and ^{95}Zr and ^{95}Nb were extracted with TBP from a freshly prepared nitric acid-potassium bromate solution. These nuclides in TBP were successively back-extracted with various aqueous solutions: $^{141,144}Ce$ with hydrogen peroxide and nitric acid solution, ^{91}Y with hydrochloric acid solution, and ^{95}Zr–^{95}Nb with oxalic acid solution. The other nuclides were not extracted by the TBP and remained in the nitric acid and potassium bromate solutions. (auth)

22418 SEPARATION OF PROMETHIUM AND AMERICIUM BY REVERSED PHASE CHROMATOGRAPHY. Kenju Watanabe. J. Nucl. Sci. Technol. (Tokyo), 2: 112-14(Mar. 1965).

The separation of ^{149}Pm and ^{151}Pm from irradiated Nd and of ^{241}Am from a Pm sample was effected by reversed-phase chromatography using di(2-ethylhexyl) phosphoric acid. (D.C.W.)

22419 CHROMATOGRAPHIC DISTRIBUTION OF RARE EARTHS WITH DI-(2-ETHYLHEXYL)ORTHOPHOSPHORIC ACID. I. EFFECT OF OPERATING CONDITIONS ON THE SEPARATING POWER OF COLUMNS. H. Grosse-Ruyken and J. Bosholm (Technische Universitat, Dresden). J. Prakt. Chem., 25: No. 1-2, 79-87(1964).

The optimal operating conditions for a chromatographic distribution column containing di(2-ethylhexyl)orthophosphoric acid (HDEHP) absorbed on silica gel as a constant phase were determined by use of a radioactive tracer technique with europium as the element. Investigated simultaneously was the dependence of the high equivalent theoretical plate (symbolized HETP) on loading with undiluted HDEHP, elution velocity and temperature, silica gel grain size, packing density, concentration of HDEHP diluted in toluene, concentration of HCl used in the extraction, and load of europium in the column. Data are given in tabular form. (JPRS)

22420 OPERATING EXPERIENCE FROM A CONTINUOUSLY WORKING CHEMICAL DECONTAMINATION PLANT. S. Krawczynski, R. Amavis, J. Vaccarezza, and S. Vannuzzi (Euratom CCR, Ispra, Italy). Kerntechnik, 7: 119-21(Mar. 1965). (In German)

The chemical decontamination plant designed for continuous operation in the Joint Nuclear Research Center–Ispra Establishment is characterized by the simplest kind of apparatus feasible and a high operational safety. The running and maintenance of the plant requires only one hour's work per day. The sludge thickening is done in decantation vessels and by subsequent desiccation in an air current. The Harwell method was chiefly applied, and, consequently, the decontamination values obtained correspond to those resulting from the above-mentioned process. (auth)

22421 APPARATUS FOR FAST RADIOCHEMICAL SEPARATIONS BY COPRECIPITATION WITH CARRIERS. G. K. Wolf (Technische Hochschule, Munich). Kerntechnik, 7: 122-3(Mar. 1965). (In German)

A description is given of an apparatus by which radiochemical separations can be executed rapidly and with high separation factors on a laboratory scale by means of carrier coprecipitation. An example shows the efficiency of the method. (auth)

22422 EXTRACTION OF THE URANYL ION BY 8-HYDROXYQUINOLINE AND TRIBUTYLPHOSPHATE IN BENZENE SOLUTION. Kung-pao Wu and Kuang-hsien Hsu. K'o Hseuh T'ung Pao, No. 12, 45-6(1963).

The uranyl ion (UO_2) can be extracted into the benzene layer from water by forming a complex with 8-hydroxyquinoline (Hox) and tributyl phosphate (TBP). Using UO_2^{++} extraction as an example, a general method for calculating the equilibrium constant of complex formation with these reagents was developed, involving derivation of the distribution ratio and distribution constants of the complexing agents in the immiscible solvents. The compositions of the complexing agents in the complex and the equilibrium constant of the complex between $(UO_2)Ox_2 \cdot TBP$ and (UO_2) Ox2Hox were calculated. Tests showed that the results of extraction with the mixed complexing agent was better than that of extraction using Hox only. In the UO_2^{++} complex, one molecule of Hox could be replaced by one molecule of TBP. (CFSTI)

22423 EXTRACTION OF PROTACTINIUM FROM HYDROCHLORIC ACID SOLUTIONS BY TRIBUTYPHOSPHATE. I. D. Bulanova and A. M. Vorobev. Radiokhimiya, 6: 621-3 (1964). (In Russian)

In the presence of $[H^+]$ and $[Cl^-]$ ion concentrations from 2 to 6M and $\mu = 5$ to 6, protactinium was extracted in the organic phase in the form $HPaOCl_4$, solvated with two molecules of TBP. (tr-auth)

22424 EXTRACTION OF PROTACTINIUM FROM HYDROCHLORIC ACID SOLUTIONS BY METHYLISOBUTYLKETONE. I. D. Bulanova and A. M. Vorob'ev. Radiokhimiya, 6: 623-6(1964). (In Russian)

The data obtained confirmed the efficiency of methyl isobutyl ketone as a solvent for the quantitative extraction of ^{233}Pa from hydrochloric acid solutions. At H^+ and Cl^- concentrations from 2 to 6M and $\mu = 5$ to 6, protactinium was extracted in the form of H_2PaOCl_5. (tr-auth)

22425 STUDY OF THE EXTRACTION AND COMPLEXING OF PLUTONIUM(IV) WITH N-BENZOYLPHENYLHYDROXYLAMINE. M. K. Chmutova and Yu. A. Zolotov. Radiokhimiya, 6: 640-6(1964). (In Russian)

A study was made of the mechanism of plutonium extraction with N-benzoylphenylhydroxylamine (BPHA) from nitric acid solutions. Experimental conditions suitable for studying the complex formation and the distribution of the

complexes between the phases were chosen. The extraction of plutonium was studied as a function of the pH, concentration of BPHA, concentration of plutonium, and nature of the solvent used for BPHA (benzene, chloroform, carbon tetrachloride, and amyl acetate). On the basis of the data obtained, the composition of the extracted complex, its distribution coefficients in the systems $CHCl_3-H_2O$ and $C_6H_6-H_2O$, and its stability constant were determined. In addition, the stability constants of intermediate complexes existing in the aqueous phase were determined. It is shown that plutonium is extracted in the form of the compound $Pu(BPHA)_4$, whose overall stability constant is equal to 2.24×10^{41}, and whose distribution coefficient in the systems $C_6H_6-H_2O$ and $CHCl_3-H_2O$ is 877 and ~3300, respectively. (ATD)

22426 STUDY OF THE EXTRACTIVE PROPERTIES OF POLYISOBUTYL-VINYLPHOSPHONATE. L. A. Fedorova, N. P. Stupin, and B. N. Laskorin. Radiokhimiya, 6: 646-51(1964). (In Russian)

The extraction of uranium from nitric acid solutions with an isobutyl phosphonate polymer was studied using infrared spectroscopy. A shift in the frequency of the stretching vibrations of the P = 0 group ($\Delta\nu = -50$ cm^{-1}) was observed in the spectrum taken when a 10M nitric acid solution was used, and the appearance of molecular vibrations of HNO_3 was established. A frequency shift in the stretching vibrations of P = 0, equal to 80 cm^{-1}, was found in the infrared spectrum of the organic phase when uranium was extracted from a 1M nitric acid solution, indicating the coordination of the metal being extracted around this group. This spectrum also showed the characteristic frequencies of the covalently bound $-O-NO_2$ group. The data obtained showed that the extraction of undissociated uranyl nitrate can be performed with the isobutyl vinylphosphonate polymer at a distribution coefficient of 0.2 (1 g of polymer in 100 ml of CCl_4) and a ratio of $UO_2(NO_3)_2$ to the extracting agent of 1:2. (ATD)

22427 REACTOR FUEL PROCESSING. Volume 8, Number 1. Stephen Lawroski, ed. (Argonne National Lab., Ill.). Winter 1964-1965. $0.70(GPO) (Domestic), $0.90 (GPO) (Foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). 67p.

Six articles are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual sections see: 22428, 22429, 22430, 22629, 23069, and 24198.

22428 COMMERCIAL ASPECTS OF FUEL PROCESSING. Reactor Fuel Process., 8: No. 1, 1-7(Winter 1964-65).

Information is included on new domestic and foreign plans for fuel processing, commercial development of processing at Hanford, transportation of irradiated fuel, cost for processing of converter reactor fuel, and radiochemical plant safety. (P.C.H.)

22429 RESEARCH AND DEVELOPMENT ON AQUEOUS PROCESSING. Reactor Fuel Process., 8: No. 1, 8-17 (Winter 1964-65).

Improvements and broadened applications of solvent extraction techniques for aqueous processing are reviewed. Developments in shearing of fuel tubes containing uranium dioxide, dissolution of zirconia, zirconium alloys, sintered aluminum powder, and refractory oxides, and in the treatment of graphite and carbide compositions are also discussed. Construction details for the Mark X contactor are included, and a concept of a contractor for radiochemical plant use is given. (P.C.H.)

22430 RESEARCH AND DEVELOPMENT ON NONAQUEOUS PROCESSING. Reactor Fuel Process., 8: No. 1, 18-36(Winter 1964-65).

Nonaqueous methods for processing irradiated fuels are reviewed. These methods include: volatility processes; pyrometallurgical processes; and oxide fuel processes. 61 references are included. (P.C.H.)

22431 ELIMINATION OF TRACE AMOUNTS OF Fe, Cu, Co and Ni FROM SOLUTIONS OF LANTHANUM AND CERIUM NITRATE. M. P. Belov. Tr. Gos. Inst. Prikl. Khim., No. 51, 16-19(1964).

A chromatographic method for freeing cerium and lanthanum nitrate solutions from trace amounts of Fe, Cu, Co, and Ni was developed. Cu was determined colorimetrically by complexing it with diethyldithiocarbamate in isoamyl alcohol, Ni by precipitation with diethylglyoxime at pH 10 in the presence of tartaric acid, Fe by the thiocyanate method, and Co spectroscopically. Purification of a 10% $La(NO_3)_3$ solution (pH 5) containing 0.001% Fe, Co, Ni, and Cu by absorption on a column filled with charcoal plus 5,7-dibromo-8-hydroxyquinoline (5:1) at a flow rate of 40 to 50 ml/hour resulted in a solution containing only 5×10^{-5}% Fe, 5×10^{-6}% Cu, 1×10^{-5}% Ni, and less than 3×10^{-4}% Co. This method is considered preferable to fractional precipitation of lanthanum hydroxide or lanthanum carbonate, addition of freshly precipitated CdS, or chromatography on columns containing charcoal plus either dimethylglyoxime or α-nitroso-β-naphthalene. Similar results were obtained with a 10% $Ce(NO_3)_3$ solution at pH 5, in which the concentrations of Fe and Cu were reduced from 1×10^{-3}% to 1×10^{-5}% and 5×10^{-6}%, respectively. (CFSTI)

22432 REMOVAL OF FISSION-PRODUCT NOBLE GASES FROM THE HELIUM OF A HIGH-TEMPERATURE GAS-COOLED REACTOR USING CHARCOAL AT LOW TEMPERATURE. H. de Bruijn (Atomic Energy Establishment, Winfrith, Dorset, Eng.), A. Gruetter, E. Roemberg, J. C. Shorrock, L. Werner, and F. C. Wood. Trans. Inst. Chem. Engrs. (London), 42: T365-86(1964).

A study was made of the removal of fission-product noble gases from helium by low-temperature adsorption on charcoal in support of the development of the O.E.C.D. High-Temperature Reactor Dragon Project. Results of experiments on the breakthrough of krypton, xenon, and other single gaseous impurities in helium carrier-gas streams on both laboratory and semi-technical scales are presented. It was found that gas-pore diffusion governs the rate of breakthrough in the former, whereas external fluid-phase diffusion appears to predominate in the latter during the early stages of breakthrough. Rate determinations confirmed the applicability of gas-pore diffusional control in the absence of helium carrier gas. Static and dynamic equilibrium data were obtained for both xenon and krypton on charcoal at low temperatures. Good agreement was obtained between the results, which can also be fitted to the Dubinin-Polanyi thermodynamic adsorption concept. It is considered probable that a "characteristic curve" can be constructed for a particular adsorbent, which can be used to predict adsorption equilibrium data for other gases for which experimental data are not available. It was concluded that sufficient margin exists in the present design of the fission-product removal plant of Dragon to permit considerable optimization for commercial development. (auth)

22433 URANIUM EXTRACTION WITH TRIPHENYLARSINIC OXIDE. R. Pietsch and G. Nagl (Universitat, Graz). Z. Anal. Chem., 208: 328-32(1965). (In German)

Uranyl ions can be extracted from aqueous solutions by means of triphenylarsinic oxide in chloroform within a pH range of 2 to 3. Separations from several foreign ions can be achieved without any complications; ions coextracted with uranium can be masked by EDTA. Examples are described. (auth)

22434 STABILITY CONSTANTS OF LANTHANUM COMPLEXES WITH DIBUTYL PHOSPHORIC ACID. Z. A. Sheka and E. I. Sinyavskaya. Zh. Neorgan. Khim., 10: 394-7(Feb. 1965). (In Russian)

Solubility of lanthanum dibutylphosphate $La[(C_4H_9O)_2PO_2]_3$ in dibutylphosphoric acid and stability constants of LaA^{2+}, LaA_2^+, and LaA_3 complexes were determined. The logarithms of the constants were 1.8 ± 0.05, 3.5 ± 0.25, and 4.62 ± 0.5, respectively (R.V.J.)

22435 SEPARATION OF THORIUM AND URANIUM(VI) IN KU-1 RESIN. A. I. Zhukov, E. I. Kazantsev, and V. A. Vakulenko (Kirov Ural Polytechnic Inst., USSR). Zh. Prikl. Khim., 38: 43-7(Jan. 1965). (In Russian)

By study of the separation of thorium and uranium(VI) on KU-I resin it was found that the sorption of thorium and uranium(VI) and washing of uranium(VI) with slightly acid solutions guarantees the separation of thorium and uranium (VI) after one ion-exchange cycle through a large charge column. Increases of the charge of the columns for the separation of thorium and uranium(VI) favors the high penetrability of the resins for hydroxy complexes of thorium. (tr-auth)

22436 THE PLUTONIUM PLANT OF THE ATOMIC ENERGY ESTABLISHMENT, TROMBAY. Trombay, India, Atomic Energy Establishment, [1964]. 27p.

A plant was designed and built at Trombay for the extraction of plutonium from irradiated natural uranium fuel elements. The plant layout is described and the process discussed. The plant operates on a Purex type process with a co-decontamination cycle, a partition cycle, and two separate parallel cycles for the purification of uranium and plutonium. Equipment, laboratories, waste disposal, instrumentation, fabrication and installation problems, and the ventilation system are described. (M.C.G.)

22437 6 IN. LEAD CAVES (Engineering Materials). (Lawrence Radiation Lab., Univ. of California, Livermore). 231 drawings, 6 photographs. (CAPE-1075)

Heavily-shielded, remotely-operated caves used in processing radioactive reactor slugs containing gram quantities of plutonium, americium, and curium are described. The caves confine the kilocurie α activity, corrosive chemicals, and the γ and β activity. The cell is constructed of interlocking 6-in. thick lead blocks on the front face, while the side walls, ceiling, and rear walls are constructed of standard concrete. Castle manipulators equipped with air-tight booting are employed for mechanical manipulation. The enclosure or cell boxes are fabricated from mild steel and are corrosive proofed with baked phenolic resins. Plexiglass windows are used on the front of the boxes and a translucent panel is used in the rear of the boxes for viewing. The ventilation system provides one air change per minute of fresh, filtered air to each enclosure. Exhaust air is passed into high-efficiency refrigerated scrubbers followed by banks of high efficiency filters. Monitors sensitive to α, β, and γ activity monitor gases before they are exhausted into the stack. (For details, see TID-4100) (M.C.G.)

22438 COLUMN LEACHER (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 1 drawing. (CAPE-870)

The column leacher described is used in the recovery of enriched uranium from powdered uranium oxides. It is used to dissolve continuously the uranium in equipment of completely safe geometry. Although critically safe, it is not as efficient as a large dissolver pot. (For details, see TID-4100) (M.C.G.)

22439 METHOD FOR THE PREPARATION OF ION EXCHANGERS, ESPECIALLY FOR THE ADSORPTION OF IONS OF RADIOACTIVE ELEMENTS. Ortwin Bobleter and Karl Buchtela. Austrian Patent 216,976. Filed Apr. 28, 1960. (In German)

A method is given for the preparation of ion exchangers for the adsorption of ions of radioactive elements, by sulfiting lignin-containing substances, especially in the form of chips, wools, or dusts. The lignin was reacted at a pH value over 6 and a temperature between room temperature and 200°C. The lignin was placed in an alkali substance and SO_2 gas was introduced into the solution. (J.S.R.)

22440 BERYLLIUM OXIDE EXTRACTION PROCESS. (to Beryloy Ltd.). British Patent 980,992. Jan. 20, 1965. Priority date Apr. 19, 1961, Canada.

A simplified process for extracting beryllium oxide from Be-containing ores is patented. The ore is first decomposed into a mixture of oxides by some conventional method such as fusion. The oxide mixture is then finely ground and leached with a saturated solution of a soluble Be salt, preferably $BeSO_4$, to dissolve out the beryllium while leaving the other metallic oxides substantially undissolved. The leaching process is carried out at 180°C for at least 6 hr. The pregnant leach solution is recovered by conventional washing, filtering, or centrifuging with the solids left after extraction being discarded as a single toxic waste product. Small amounts of aluminum oxide in the solution may be easily removed before the BeO is precipitated. (A.G.W.)

22441 METHOD OF TREATING PARTLY USED NUCLEAR FUELS. (to European Atomic Energy Community). British Patent 981,044. Jan. 20, 1965. Priority date June 22, 1961, Belgium.

Uranium and plutonium are separated from partly used nuclear fuels by treating the fuels with anhydrous or aqueous hydrofluoric acid in liquid or gas phase to obtain, in a single state, UF_4, PuF_4, and PuF_3. These fluorides may then be converted into hexafluorides by a fluoriding agent, into oxides by pyrohydrolysis, or into metals by reduction with Ca or Mg. (A.G.W.)

22442 METHOD FOR THE PREPARATION OF A URANIUM(IV) NITRATE SOLUTION WHICH IS SUITED AS REDUCING AGENT FOR PLUTONIUM IN REPROCESSING IRRADIATED FUEL ELEMENTS. Alberto Cacciari, Ruggero de Leone, Sergio Ferrari, and Guido Cogliati (to Comitato Nazionale per l'Energia Nucleare). German Patent 1,176,631. Aug. 27, 1964. Priority date Dec. 5, 1961, Italy.

An aqueous uranyl nitrate solution containing less than 1.2 mol/l free nitric acid was reduced with gaseous hydrogen in the presence of a catalyzer of a metal of the platinum group. The metal is either ground or fixed on an indifferent carrier with a large surface. (Gmelin Inst.)

22443 PURIFICATION OF STRONTIUM SOLUTIONS BY ION EXCHANGE. Earl J. Wheelwright, Lano A. Bray, Frank P. Roberts, and Robert Lee Moore (to U. S. Atomic Energy Commission). U. S. Patent 3,173,757. Mar. 16, 1965.

A process was developed for recovering strontium from an aqueous solution also containing calcium, lanthanides, sodium, cesium, iron, lead, ruthenium, zirconium, and niobium values as fission products. It consists of complexing the fission products with HEDTA, tartaric acid, or citric acid at a pH value of between 3.5 and 5; adsorbing noncomplexed calcium and strontium on a cation exchange resin; and fractionally eluting the calcium and strontium values with a solution of EDTA or HEDTA. (AEC)

22444 METHOD FOR SEPARATING TRANSPLUTONIUM ELEMENTS FROM RARE EARTH FISSION PRODUCTS. F. L. Moore (to U. S. Atomic Energy Commission). U. S. Patent 3,178,256. Apr. 13, 1965.

A method of separating americium and curium values from rare earths was developed. By this method americium and curium are extracted with an organic solution of a tertiary amine from an aqueous solution containing a high concentration of lithium chloride. The rare earths remain in the aqueous phase. (AEC)

22445 SEPARATION OF PLUTONIUM HEXAFLUORIDE FROM URANIUM HEXAFLUORIDE BY SELECTIVE SORPTION. G. I. Cathers and R. L. Jolley (to U. S. Atomic Energy Commission). U. S. Patent 3,178,258. Apr. 13, 1965.

A process for selectively removing plutonium fluoride values from a gaseous mixture of plutonium hexafluoride and other volatile metal fluoride values was developed. The gaseous mixture is passed through, and in contact with, a porous mass of a solid metal fluoride selected from the group consisting of lithium fluoride, sodium fluoride, and calcium fluoride at a temperature at which the plutonium fluoride is selectively sorbed on the porous mass. (AEC)

22446 COUNTERCURRENT NUCLEAR-FUEL LIQUID-LIQUID EXTRACTION APPARATUS. James P. Duckworth

(to U. S. Atomic Energy Commission). U. S. Patent 3,179,501. Apr. 20, 1965.

A column used for liquid-liquid solvent extraction is described. It has annular sections at its ends in which the liquids are disengaged from one another. The disengaging sections are provided with enclosed concrete shields so that there is no danger of a nuclear chain reaction in the large volume of liquids present in the disengaging sections. (AEC)

22447 EXTRACTION OF CESIUM FROM AQUEOUS SOLUTION USING PHENOLS. D. E. Horner, D. J. Crouse, and K. B. Brown (to U. S. Atomic Energy Commission). U. S. Patent 3,179,503. Apr. 20, 1965.

A method of recovering cesium from an aqueous basic solution is described. The cesium is extracted with an aqueous immiscible organic solvent phase consisting of a phenol selected from an o-phenylphenol, an o-benzylphenol, and a para-substituted alkyl phenol wherein the alkyl substituent contains from 9 to 20 carbon atoms, dissolved in an organic diluent to the extent of at least about 0.5 M. The cesium is recovered from the organic solvent phase. (AEC)

ENGINEERING

General

22448 (CONF-650409-1) AN INTRODUCTION TO THE ASME UNFIRED PRESSURE VESSEL CODE. C. V. Moore (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 15, 1965. Contract W-31-109-eng-52. 44p. Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

From Pressure Vessel Symposium, ASME, Idaho Falls, Idaho.

A general introduction to the ASME Unfired Pressure Vessel Code, primarily from the viewpoint of the designer, is presented. The history of the Code is outlined briefly. The areas of application of the Code are described, and the jurisdictional status of the Code is outlined. The administrative arrangements by which the Code is kept up to date and modified are discussed. The organization of the different sections of the Code are explained and the requirements of the various subsections of the Code are outlined—stressing those portions that are frequently misinterpreted or subject to dispute. Finally, current directions for future development of the Code are sketched. (auth)

22449 (EDI-123) LITERATURE SURVEY OF WATER LUBRICATED BEARING MATERIALS. J. T. Dunn and H. S. Rawcliffe (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1964. 67p. (AECL-2238). Dep.(mn); $1.50(AECL).

A survey was made of all available literature on water-lubricated bearings and the wear and friction of materials in water. Where the wear test data was given quantitatively and backed up by sufficient information, it was collected and tabulated according to materials. The reported wear results were converted to a specific wear factor, which allows comparison of the results from the various test machines and is a useful figure in design work since it gives the volume of wear per unit load per unit length of travel. (auth)

22450 (KAPL-3094) HIGH-ENERGY RATE FORMING OF OMEGA SEALS. J. E. Wilson (Knolls Atomic Power Lab., Schenectady, N. Y.). Mar. 11, 1965. Contract W-31-109-eng-52. 26p. Dep.; $2.00(cy) 1(mn) CFSTI.

Nickel–chromium–iron (Alloy 600) omega seals can be fabricated in multiple by a high energy rate forming (HERF) process. The microstructure of HERF-formed seals is similar to that of spun seals, namely sound, uniform, and fine-grained with acceptable flow-line pattern and hardness. HERF seals were successfully closure-welded using the same welding parameters as those required for spun seals. The use of HERF omega seals in place of spun seals for weld procedure and operability qualifications will permit a 50% dollar saving. (auth)

22451 (RFP-375) HYDROSTATIC BEARINGS. R. W. Skulski (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). Apr. 12, 1965. Contract AT(29-1)-1106. 11p. (CONF-640407-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 3rd Annual General Meeting of IMOG, Livermore, Calif.

A survey is presented of the operation and design of hydrostatic bearings. The mechanism of load support is described for a simple flat bearing. Flow restrictors are required when two or more bearings or recesses are supplied from a single pump. The response to load change is considered, and it is shown that the bearing stiffness changes with load. Other bearing configurations and the complications produced by large relative motion between slide and bearing are considered. It is concluded that hydrostatic bearings should be conservatively designed for static conditions. (D.L.C.)

22452 (TID-20697) SECOND-ORDER THERMAL STRESS IN A THIN ELASTIC CYLINDER. J. E. Thompson (ACF Industries, Inc., Albuquerque, N. Mex.). [May 28, 1964]. Contract AT(29-1)-1352. 18p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

The significance of second-order effects associated with the wall-thickness-to-diameter ratio due to a radial temperature gradient in a clamped, finite-length, thin elastic cylinder was investigated using a perturbation or asymptotic integration method. The relative significance of transverse shear and normal stress was also investigated, and numerical output from a FORTRAN program is presented in graphical form. (auth)

22453 MAGNETOHYDRODYNAMIC SQUEEZE FILM BEARINGS. F. T. Dodge (Southwest Research Inst., San Antonio), J. F. Osterle, and W. T. Rouleau. New York, American Society of Mechanical Engineers, 1964, Paper No. 64-WA/Lub-3, 5p. (CONF-763-45)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

A theoretical analysis is given for squeeze film bearings which use an electrically conducting fluid, such as a liquid metal, as the lubricant and which are in the presence of a magnetic field. Electrical energy is added to the film by an exterior source. By considering infinitely long rectangular plates, the fluid film thickness is determined as a function of time, with the applied magnetic and electric fields as parameters. It is shown that the squeeze action is altered significantly when the electric field is symmetrical about the center of the bearing, and results are presented for various values of the Hartmann number. (auth)

Applications of Nuclear Explosions

Refer also to abstracts 22484 and 22702.

22454 (PNE-107F) THE ENVIRONMENT CREATED BY A NUCLEAR EXPLOSION IN SALT. D. Rawson, C. Boardman, and N. Jaffe-Chazan (Lawrence Radiation Lab., Univ. of California, Livermore). Sept. 1964. Contract W-7405-eng-48. Project GNOME. Dep.; $3.00(cy), 2(mn) CFSTI.

The Gnome event, a 3.1 ± 0.5 kiloton nuclear explosion, was conducted at a depth of 361 m in bedded rock salt near Carlsbad, New Mexico. This explosion melted approximately 3.2×10^6 kilograms of rock salt and produced a standing cavity with a volume of about 27,200 cubic meters. The cavity has a pronounced bulge at its equator. The development of this asymmetry was controlled by the preshot character of the rock: horizontal weaknesses in the form of bedding planes and clay layers. The molten salt mixed with the condensing radioactive debris and about 11.6×10^6 kg of rock from the cavity walls, to form a radioactive puddle of melt and rock breccia at the base of the cavity. This zone is blanketed by about 13.6×10^6 kg of rubble that resulted primarily from ceiling collapse, thus shielding the puddle so that when personnel entered the cavity, gamma radiation levels were rarely in excess of 20 mR/hr. During the dynamic cavity growth period of about 100 msec, radial cracks propagated closely behind the outgoing compressional shock wave. The maximum observed extent of these fractures, measured from the center of the explosion, is 40 m laterally, 38 m above, and 25 m below. Leakage of radioactive gases through the rock was detectable by the presence of radiation damaged salt. Close-in stemming failed and cavity gases vented dynamically into the emplacement drift. Back-up stemming confined the dynamic venting but allowed the low pressure release of steam and gaseous fission products. The formation of radial cracks and bedding plan partings, coupled with the emplacement configuration to accommodate a neutron-physics experiment,

caused the stemming failure. Asymmetry of rock displacements, fractures observed, and the permanent surface displacements indicate localized uplift of the rock between the cavity and the ground surface. (P.C.H.)

22455 NUCLEAR EXCAVATION OF A SEA-LEVEL ISTHMIAN CANAL. Luke J. Vortman (Sandia Lab., Albuquerque, N. Mex.). J. Waterways Harbors Div., Am. Soc. Civil Engrs., 90: No. WW4, 27-54(Nov. 1964). (SC-R-64-1357)

A study was made of the application of nuclear excavation techniques to the construction of a sea-level transisthmian canal primarily to evaluate present (1964) capability and to isolate areas in which further information is required. Data on high-explosive (HE) and nuclear cratering events are combined with the 1947 Route Surveys made by the Panama Canal Company to estimate the number and yield of the nuclear devices needed to excavate a canal along nine routes. Estimates were also developed for the cost of such excavation. The calculations consider both all-nuclear and combined nuclear-mechanical methods. Savings vary with the different routes, but it is shown that the use of nuclear explosives can reduce excavation costs by as much as 90% and over-all costs by approximately 65%. Because there is uncertainty regarding scaling methods, the calculations were made with linear crater dimensions scaled both as the $\frac{1}{3.4}$ power and fourth root of explosive yield. This uncertainty did not greatly affect costs, but it did create a 250 to 300% uncertainty in the explosive yield required. Other factors considered in the calculations are long-term slope stability and different channel widths (750, 1,000, 1,250, and 1,500 ft). Doubling the channel width reduced the cost and number of devices by 20 to 30% but increased the total yield by approximately 250%. A large number of discrete yields were assumed; reduction of the number decreased cost and number of devices, but increases total yield. Among the most important areas requiring further information or experimentation are: resolution of scaling uncertainties, relative cratering effectiveness of chemical and nuclear explosives, site geology and topography, cost data for explosives and their emplacement, and the maximum single-salvo explosive yield permitted by blast and seismic safety considerations. The study suggested that nuclear excavation is promising and offers the possibility of substantial savings. However, it was also concluded that considerable experimentation is necessary before the techniques are perfected. (auth)

Facilities and Equipment

Refer also to abstract 23117.

22456 (CEA-R-2744) POMPE DE CIRCULATION ELECTROMAGNETIQUE POUR GAZ CORROSIFS. (Electromagnetic Circulation Pump for Corrosive Gases). Pierre Noe, Denise Delafosse, and Gérard Deletre (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Feb. 1965. 16p. Dep.(mn).

In order to transport very corrosive products (fluorinated compounds), a totally metallic circulation pump capable of operating at above room temperatures and with a molecular vacuum was developed. Maximum simplicity was the primary aim both in conception and operation. The tests showed that the compression ratios produced, although not high are interesting (1.5 at a pression of 100 torr). The flow-rate range is very wide: about one hundred ccs/atm/min. to 3,000 ccs/atm/min. Desorption of the pump presents no difficulty if both the aspiration and the reject sides are pumped together. A hole of 2 mm diameter drilled in the piston makes it possible to desorb the space between the two segments. The price of the pump is 1,300 F, with the electrical cabinet. (auth)

22457 (ORNL-3755) ANALYSIS OF AXISYMMETRICALLY LOADED CYLINDER-TO-SPHERE ATTACHMENTS. F. J. Witt and B. L. Greenstreet (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 52p. Dep.; $3.00(cy), 1(mn) CFSTI.

Tabulated data are presented for determining the maximum stresses and maximum stress intensities for nozzle-to-spherical-shell attachment configurations. Data for nozzles having internal protrusions, as well as for those having no internal protrusions, are included. The equations used in the analyses are given, along with a discussion of the conditions at the junction between the nozzle and shell. Comparisons are made between calculated and experimental results, and the influence of Poisson's ratio on the calculated stresses at the junction is illustrated. (auth)

22458 (ORNL-3776(p.23-37)) DEVELOPMENT OF METHODS FOR DISTINGUISHING AND MEASURING FORMS OF GAS-BORNE FISSION PRODUCTS. (Oak Ridge National Lab., Tenn.).

The behavior of volatile iodine in May packs, as indicated by composite diffusion tubes, was observed in a test with moderately moist air to be substantially consistent with the designed functions of the May pack components. Elemental iodine was removed by the Cu gauze with an estimated efficiency of 99.96%, contrasting with an earlier result of 99% obtained for the case of relatively dry air. It has been previously shown, that at high relative humidity (30 to 60%) and at room temperature, iodine vapors and particularly volatile iodine compounds in diffusion tubes fail to produce the usual deposition profiles. A possible remedy for this situation is to raise the temperature of the diffusion tube above 100°C so as to lower the relative humidity of the gas and to prevent condensation of moisture on the walls. Tests recently concluded showed that high temperatures (above 100°C) improve the efficiency of diffusion tubes, even in the presence of high humidity (60 to 80%) at the higher temperature. The improvement was sufficient to make it possible to ascertain the presence or absence of compounds of iodine in a steam environment but not sufficient to obtain distinctive deposition gradient that allowed identification of the unknown species. Efforts to improve the behavior of diffusion tubes by extracting the moisture upstream showed that not only the moisture but also the iodine species were extracted by the molecular sieve material used. One of the problems involved in separating the different forms of iodine is that filters which are inserted in filter packs to collect iodine attached to particles may adsorb molecular iodine. A systematic investigation was made to determine the iodine retention of six different filter materials in a particle-free atmosphere. A cellulose filter (Whatman No. 40) had the lowest retention of iodine, while Gelman Polypore and Acropore filters retained about one-third of the molecular iodine that passed through them. Data on the effect of filter porosity on filter efficiency as a function of flow rate are being obtained in order to test the various theories of filtration. Improvements in the experimental assembly, which consists of a series of uniform fibrous filters and a source of radioactive aerosols are described. (J.R.D.)

22459 (ORNL-3776(p.47-51)) REMOVAL OF PARTICULATE MATERIALS FROM GASES UNDER REACTOR ACCIDENT CONDITIONS. W. E. Browning, Jr., R. E. Adams, and G. L. Kochanny, Jr. (Oak Ridge National Lab., Tenn.).

A laboratory investigation was undertaken of particulate aerosol filtration simulating those expected to be generated during reactor accidents. This work thus far consists in the development of a laboratory method for generating a simulant aerosol, tests of these aerosols to determine their validity as simulants, and initial measurements of the efficiency of absolute filters for removing the simulant aerosols. The laboratory aerosol source consists of a high-intensity arc powered by a welding machine and struck between electrodes which simulate fuel materials. The aerosol so produced was shown by electron microscopy to be similar to aerosols which appear in the NSPP. Fibrous filter analyzer measurements show this aerosol to consist of two particulate species having different tendencies to penetrate filters. An absolute filter trapped one of these

species with an efficiency of >99.992% and the other >99.91%. (auth)

22460 (ORNL-3776(p.52-3)) FILTER TESTS IN THE NUCLEAR SAFETY PILOT PLANT. C. E. Guthrie, J. M. Holmes and L. F. Parsly (Oak Ridge National Lab., Tenn.).

Equipment was designed and is being fabricated for pilot-plant-scale tests of adsorbers and filters using the pilot plant aerosols. (auth)

22461 (ORNL-3776(p.57-70)) BEHAVIOR OF RADIOIODINE IN THE CONTAINMENT MOCKUP FACILITY. G. W. Parker, W. J. Martin, G. E. Creek, and C. J. Barton (Oak Ridge National Lab., Tenn.).

All experiments on iodine behavior in the Containment Mockup Facility (CMF) during the report period were made with steam-air mixtures in the containment tank. Comparison of the results obtained with those obtained when the tank was filled with air of normal humidity showed that the dry stainless steel surface retained more iodine than the wet surface and that less iodine was removed from the wet tank at the conclusion of the run than from the dry tank, except when organic materials were present in the tank. Approximately half of the iodine in the tank was always found in the steam condensate under the conditions used in these experiments. The amount of iodine penetrating a ¾-in. bed of charcoal varied from 0.01% in dry, filtered air to 4% in a steam-air mixture containing some acetone. Significant amounts of iodine, presumably gaseous organic iodide, were always found when organic materials were present in the containment tank. However, efforts to make methyl iodide by direct reaction of CH_4 and I_2 at 200°C in a 10,000-curie cobalt irradiation facility proved fruitless. The mechanism by which organic gases react to form organic iodides is not clear. Difficulties were experienced in characterizing forms of iodine present in steam-air mixtures. Retention by Ag screens and by charcoal papers was erratic. Heating the complex filter pack used to separate the different forms of iodine to 100°C gave satisfactory results in the charcoal-containing portions of the samples, but consistent deposition data on Ag screens were more difficult to obtain. Ag-lined and charocal-lined diffusion tubes were used in series to determine the amounts of penetrating iodine in side streams removed before and after the charcoal papers of the complex filter pack. The amount of iodine in this form ranged from 2.5 to 21% of the iodine inventory in three experiments where mixed hydrocarbons formed by hydrolysis of uranium carbide were present in the aerosol. On the basis of rather fragmentary results, it appeared that the presence of vaporized fuel particles increased the fraction of iodine in the penetrating form. (auth)

22462 (WAPD-288) TEST RIG FOR USE IN WEAR AND FRICTION STUDIES IN A WATER ENVIRONMENT. N. B. Dewees (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar. 1965. Contract AT-11-1-GEN-14. 39p. Dep.; $2.00(cy), 1(mn) CFSTI.

A test rig is described for measuring the rate of wear and the coefficient of friction for materials tested in a pressurized water environment at temperatures to 500°F. The rig operates with either a continuous sliding or an oscillating motion. Two different designs of specimens are tested simultaneously to show in a single test whether loading or design of specimens may significantly affect test results. Tests can be performed with a unit loading on the wear surfaces of 30 to 9000 psi with the standard specimens. Evaluation of a material combination is based upon relative wear rates between the two types of specimens as well as the magnitude and trend of wear rate and roughness in successive test intervals. Examples are given for material combinations having widely different performance. (auth)

22463 IMPROVEMENT AND BOOSTING OF V01 HYDROGEN LIQUEFIER. A. G. Zel'dovich and Yu. K. Pilipenko (United Inst. for Nuclear Studies, USSR). Cryogenics, 5: 45(Feb. 1965).

The following changes were introduced into the V01 hydrogen liquefier which improves its performance and efficiency for heat exchangers: increased opening in the nitrogen siphons, altering the method of processing the catalyst for the ortho-para conversion of hydrogen, insertion of platinum resistance thermometers and the addition of two 2RG3-350 compressors. The results of operating the liquefier under normal and boosting conditions are shown. (L.B.S.)

22464 A SIMPLE DEVICE FOR PRESSURIZING HELIUM-3. D. F. Brewer, D. O. Edwares, and D. R. Howe (Univ. of Sussex, Falmer, Eng.). Cryogenics, 5: 47-8 (Feb. 1965).

A device for pressurizing ^3He is described, in which the ^3He is absorbed on zeolite at 4°K. The device is designed for use as a high pressure store of ^3He-^4He mixtures for a low-temperature experiment requiring only a small amount of gas. (L.B.S.)

22465 THE ELECTRIC INSTALLATIONS IN THE EURATOM JOINT NUCLEAR RESEARCH CENTER AT ISPRA. Piero Muratori (C.C.R. EURATOM, Ispra, Italy). Ing. Nucl., 5: No. 2, 1-14(1964). (In Italian) (EUR-2256.i)

The conventional electric installations of the European Atomic Energy Community, Euratom–Ispra, are described with reference to the tests that proceeded to the projects and realizations of those installations. Especially, the installations relative to the transformation and distribution of medium and low tension for the electric energy in the Center are treated. (auth)

22466 AN EXPERIMENTAL UNIT FOR CHRONIC IRRADIATION OF ANIMALS. I. A. Gamzaeva and Sh. M. Salimov. Med. Radiol., 10: No. 3, 81-2(Mar. 1965). (In Russian)

An experimental cobalt irradiation unit, enabling long-term irradiation of a large number of animals, is described. (auth)

22467 STUDY ON THE PREVENTION OF LEAKAGE FROM THE GASKET FLANGE CONNECTION OF REACTOR PRESSURE VESSEL. Tatsuta Mizokami (Mitsubishi Heavy Industries Ltd., Japan). Mitsubishi Heavy Ind. Tech. Rev., 1: 341-51(Nov. 1964). (In Japanese)

For fastening the upper head on the body of a pressure vessel it is desirable to increase the durable strength of the pressure vessel and decrease the stress in the closure bolts by the employment of packings with excellent sealing qualities. Studies on prearranged metal "O" rings for the sealing of the pressure vessels for nuclear reactors were conducted. As the results of leak tests using three models of the flange connections of large, medium, and small sizes, it was found that the hollow metal "O" rings showed excellent sealing ability. Moreover, the various conditions required when using such metal "O" rings were established. (auth)

22468 ONE-KILOCURIE COBALT-60 GAMMA IRRADIATION FACILITY OF THE RADIOCHEMISTRY RESEARCH LABORATORY OF SHIZUOKA UNIVERSITY. Kunihiko Hasegawa (Shizuoka Univ., Shizuoka City, Japan). Repts. Liberal Arts Sci. Faculty Shizuoka Univ., Nat. Sci., 3: 223-7(Jan. 1964).

For the study of chemical and physical effects on materials, one-kilocurie cobalt-60 gamma-ray source was constructed at the Radiochemistry Research Laboratory of Shizuoka University in June 1960. The construction of its irradiation cave, the design of the cobalt-60 gamma-ray source, and the leakage of radiation are described. (auth)

22469 IMPROVEMENTS IN OR RELATING TO SHAFT SEALING ARRANGEMENTS. John Archibald Little (to C. A. Parsons and Co., Ltd.). British Patent 980,895. Jan. 20, 1965. Filed June 30, 1963.

A shaft-sealing arrangement for preventing or reducing contamination of a gas in an enclosure by oil or other liquid passing along a rotating shaft passing through or associated with the enclosure is patented. The arrangement includes a conventional thrust collar seal and a

plurality of stationary radial baffles lying in planes extending longitudinally of the shaft. The baffles are disposed in spaced relation along the periphery of the shaft around a portion of the shaft between the sealing ring and the gas in the enclosure. Means are provided for collecting oil or other liquid trapped by the baffles. The baffles may be associated with labyrinth glands. (A.G.W.)

22470 IMPROVEMENTS IN OR RELATING TO REMOTE CONTROL MANIPULATING APPARATUS. Phillippe Wallet and Henri Taverne (to Commissariat a l'Energie Atomique). British Patent 981,189. Jan. 20, 1965. Priority date Jan. 12, 1961, France.

The apparatus described is intended for manipulating radioactive objects located on one side of an enclosure wall by means located on or communicating with the other side of the wall. The apparatus includes a tubular member rotatably projecting through the wall in a fluid-tight manner and tiltably receiving a support provided with clamping jaws. The connection between the tubular member and the tiltable support is fluid-tight. A motor controls tilting movement of the support with respect to the tubular member, rotation of the tubular member about its axis, and movement of the clamping jaws toward and away from each other. Preferably means are included that allow the operator to follow the displacements of the active members inside the wall on dials so that visual control is unnecessary. (A.G.W.)

22471 IMPROVEMENTS IN OR RELATING TO FLUID FLOW CONTROL VALVES. (to Babcock and Wilcox Co.) British Patent 981,894. Jan. 27, 1965. Priority date Jan. 23, 1961, United States.

A check valve in which water hammer is materially reduced is patented. The valve has a body with an inlet and outlet, a valve seat arranged within the body transversely to the longitudinal axis of the inlet, and a pivoted closure member movably mounted in the body to form a sealing means with the valve seat between the inlet and outlet. The body has an offset portion between the valve seat and the outlet so shaped that the ratio of the flow area between the edge of the closure member and the valve body to the flow area between the edge of the closure member and the valve seat during closing of the valve is within the range 0.8 to 1. (A.G.W.)

Heat Transfer and Fluid Flow

See also PHYSICS — General.

Refer also to abstract 24082.

22472 (AE-176) EFFECT OF BUOYANCY ON FORCED CONVECTION HEAT TRANSFER IN VERTICAL CHANNELS. A Literature Survey. Ajay Bhattacharyya (Aktiebolaget Atomenergi, Stockholm (Sweden)). Mar. 1965. 27p. Dep.(mn).

A survey was made of available information on the effects of free convection flow on forced convection heat transfer in vertical channels. Both theoretical and experimental investigations are included. Nearly all of the theoretical investigations are concerned with laminar flow with or without internal heat generation. More consistent data are available for upward flow than for downward flow. Curves are presented to determine whether free convection or forced convection mode of heat transfer is predominant for a particular Reynolds number and Rayleigh number. At $Re_b > 10^5$ free convection effects were found to be negligible. 39 references are included. (P.C.H.)

22473 (AERE-R-3960) HEAT TRANSFER TO TWO-PHASE GAS-LIQUID SYSTEMS. PART III. THE EFFECTS OF PROXIMITY OF OTHER HEATED SURFACES. J. G. Collier, P. M. C. Lacey, and D. J. Pulling (Atomic Energy Research Establishment, Harwell (England)). Feb. 1962, Revised Nov. 1964. 32p. Dep.; $1.00(BIS), 5s.(HMSO).

Experiments were carried out in a test section which, in cross section, resembles part of a rod cluster type fuel element for a boiling water reactor. Measurements were made of heat transfer coefficient, pressure drop, and burnout heat flux as a function of mass velocity, quality, rod spacing, and secondary heat flux on the surrounding elements. When burnout heat flux was plotted against exit quality an apparent augmentation of the flux was noted for the condition where both surfaces of the duct were heated as compared to the value obtained with just the inner surface heated. Under certain conditions this increase may be explained by postulating a simple flow model incorporating current ideas on burnout while for other conditions the picture is very confused. There does not appear to be any significant separate effect of secondary heating upon the heat transfer coefficient from the primary surface to the steam-water mixture or upon the pressure gradient. (auth)

22474 (ANL-7002) A LARGE, HIGH-FIELD, SUPERCONDUCTING MAGNET SYSTEM. C. Laverick and G. M. Lobell (Argonne National Lab., Ill.). Jan. 1965. Contract W-31-109-eng-38. 15p. Dep.; $1.00(CFSTI).

A superconducting magnet system composed of three separate, easily removable, nested solenoids is described. The outer two solenoids are split-coil systems so that particle beams can be directed through the magnet when these sections are used to provide the magnetic field for a helium bubble chamber. Magnetic fields of 67, 42, and 17 kG have been achieved in winding diameters of 7, 11, and 18 in., respectively. The results indicate that the system is capable of operation at fields in excess of 70 kG. The magnet is wound from various types of superconducting cable. Some of the considerations governing the choice of cable types and magnet design are presented. The tests carried out on the magnet system are described, and the test results are discussed. (auth)

22475 (BNWL-34) THE LOW-PRESSURE CRITICAL DISCHARGE OF STEAM–WATER MIXTURES FROM PIPE ELBOWS AND TEES. F. R. Zaloudek (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1965. Contract AT(45-1)-1350. 27p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

An investigation was made on the critical discharge of two-phase steam-water mixtures from a piping system when the system is opened to the atmosphere adjacent to a tee or elbow. Two phenomena uniquely determine the maximum rate at which a two-phase mixture can be discharged from such a system: the critical flow phenomenon; and the two-phase pressure-drop phenomenon. Experiments were performed at moderate temperatures and pressures on ½ in. commercial piping and welding fittings to study the effects of the presence of the fitting on these phenomena. The range of steam-water total enthalpies considered was between 23 and 87 psia. The results indicated that the elbow at the discharge of the flow passage influenced the critical flow rate insignificantly. The tee in this location reduced the critical discharge rates from 10% at enthalpies of 900 and 1000 Btu/lb up to 24% at 500 Btu/lb. This indicates that the tee immediately upstream of the location of the flow choking acts to increase the degree of homogenization of the two-phase mixture. (P.C.H.)

22476 (CEA-R-2741) SUSPENSION DE GRAPHITE DANS LE GAZ CARBONIQUE. (Graphite Suspension in Carbon Dioxide). Roland Roche, Claude Moussez, Xavier Rouvillois, and Roland Brevet (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1965. 37p. Dep.(mn).

Experimental work with a two-component fluid comprised of carbon dioxide and small graphite particles was made for the determination of basic engineering information pertaining to the stability and the flowability of the suspension. The final form of the experimental loop consists mainly of the following items: a light-phase compressor, a heavy-phase pump, an electrical-resistance type heater section, a cooling heat exchanger, a hairpin loop, a transparent test section, and a separator. During the course of the testing, it was observed that the fluid could be circulated quite easily in a broad range of variation of the suspension den-

sity and velocity–density from 30 to 170 kg/m³ and velocity from 2 to 24 m/sec. The system could be restarted and circulation maintained without any difficulty, even with the heavy-phase pump alone. The graphite did not have a tendency to pack or agglomerate during operation. No graphite deposition was observed on the wall of the tubing. A long period run (250 hours) showed the evolution of the particle dimensions. Starting with graphite of surface area around 20 m²/g (graphite particles about 1 μ), the powder surface area reached an asymptotic value of 300 m²/g (all the particles less than 0.3 μ). Moisture effect on flow stability, flow distribution between two parallel channels, pressure drop in straight tubes, recompression ratio in diffusers were also investigated. (auth)

22477 (CISE-98) PHASE AND VELOCITY DISTRIBUTION IN TWO-PHASE ADIABATIC DISPERSED FLOW. L. Cravarolo and A. Hassid (Centro Informazioni Studi Esperienze, Milan (Italy)). Aug. 1963. 32p. (CONF-309-5). Dep.(mn).

From EAES Symposium on Two Phase Flow Steady State Burnout and Hydrodynamic Instability, Studsvik, Sweden, Oct. 1963.

Some experimental results obtained on the hydrodynamics of two-phase (gas + liquid) mixtures in annular-dispersed flow. Remarks are made concerning the mechanism of the flow pattern. A possible connection between some hydrodynamic parameters, such as the film liquid flow rate, and the heat transfer properties, is put in evidence. Phase and velocity distribution in the core was determined by means of a probe that could operate either as a Pitot probe or as an isokinetic sampling probe. The experiments were carried out at high pressure (up to 22 kg/cm² abs) and room temperature with argon-water and argon-ethanol mixtures in adiabatic vertical flow. The results showed that the liquid volume fraction has a minimum in correspondence with the axis of the conduit; it increases with radius and reaches a unit value on the wall. Also, the gas volume fraction may be large in the region, usually called film, where the liquid is the continuous phase. (P.C.H.)

22478 (CONF-640607(Vol.II)(Paper D-6)) APPLICATION OF THE TURBINE TYPE FLOW METERS IN THE MEASUREMENTS OF STEAM QUALITY AND VOID. S. Zia Rouhani (Aktiebolaget Atomenergi, Stockholm (Sweden)). 12p.

Behavior of a turbine-flowmeter in two-phase flow is studied both experimentally and theoretically. Experiments include the measurements of mass flow rate, steam quality, and void volume fraction at the outlet of a heated channel. Theoretical equations based on the momentum exchange principle are derived to explain the behavior of the turbine flowmeter. It is shown that the assumption that the liquid velocity alone counts for the rotation of the turbine is not valid in general. An expression is found theoretically for the rotational speed of a turbine flowmeter in two-phase flow. In the light of this exact equation, it is suggested that the turbine type flowmeters be used to indicate steam quality, void, and even enthalpy carried by two-phase flow. The method is applicable in nuclear as well as in conventional boiling systems. (auth)

22479 (DPST-65-83-2(p.3-7)) EFFECT OF ROD SPACING ON HEAT TRANSFER BURNOUT. R. H. Towell (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.).

In a practical reactor design the amount of light water poison in the fuel coolant channels would be minimized to limit the reactivity changes associated with vaporizing the coolant. This can be achieved by operating with closely spaced fuel rods and high outlet steam qualities. An attempt was made to determine the effects of these variables on the heat transfer and hydraulic characteristics of rod bundles. Burnout heat fluxes and effluent qualities in two tests with 0.018-inch rod spacing were slightly higher than measured previously with 0.050-inch rod spacing. The results indicate that the amount of coolant in a rod bundle assembly can be reduced by closely spacing the fuel rods without affecting the heat flux or quality at burnout. Consequently, the reactivity changes associated with vaporizing the coolant in a D_2O-moderated, H_2O-cooled power reactor might be reduced by closely spacing the fuel rods without reducing the power output of the assemblies. (C.E.S.)

22480 (EUR-2182.e) THE INFLUENCE OF LOCAL ABSENCE OF COOLING ON THE FUEL CLADDING TEMPERATURE. C. M. Kalker (Reactor Centrum Nederland, The Hague (Netherlands)). 1965. 18p. Dep.(mn).

The temperature rise at the position of support of the fuel rods that results from the local absence of cooling was calculated. Support of the fuel rod is represented by a small circle, lying on the outer surface of the cladding, which simulates the contact area between fuel rod and supporting grid. The temperature rise is considered as a perturbation term superimposed on the undisturbed temperature distribution. Two extreme cases are considered, namely complete isolation of the perturbation term and complete cooling of the perturbation term outside the small circle. In order to compare with experimental results the same calculations are applied to a case of heat production in a steel tube, which is heated electrically. (auth)

22481 (EURAEC-1288) PROGRESS OF WORK DURING THE FOURTH QUARTER 1964. Quarterly Report No. 19. C. Moussez (Société Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes (France). Division Atomiques). Jan. 11, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 061-64-7-TEEF. 9. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in measurements of 20 mm-dia. circular channel pressure drop, flow quality, and corrosion film thickness. Tests on a 2-channel cruciform section are discussed. Thermal studies on a 20-mm circular section with evolutive flux are discussed along with studies on a test section with direct heating by Joule effect. A test section with nine heating rods was designed. (J.R.D.)

22482 (EURAEC-1332) HEAT TRANSFER AND FLUID FLOW CHARACTERISTICS IN A PRESSURIZED WATER REACTOR. Quarterly Progress Report IV, October 1, 1964–January 1, 1965. (Technische Hogeschool, Eindhoven (Netherlands)). Jan. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 011-64-1 Teen(RD). 21p. (EUR-2309). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Repairs have been carried out on the 140-atmosphere pressurized water loop in order to improve the loop behavior and operational characteristics. A regenerative and nonregenerative cooler have been installed in the loop between the primary circuit and the ion-exchangers, making the water treatment equipment complete. All foreign materials such as copper and solder have been removed from the loop. Furthermore, another filling and start-up procedure, including pre-operational flashing with argon and filling with water boiled half an hour has been established. This procedure resulted in a very good loop behavior considered from the point of view of the water characteristics, scaling of the heating elements, and adjustment of prescribed conditions. The conductivity of the water just before and after the ion-exchangers was respectively 0.9 and 0.2 μ Siemens, the pH value was 7.2 and 6.8, and the SiO_2 content less than 0.2 and 0.1 mg per liter respectively at these conductivities. The O_2 content in the primary process water was less than 0.2 mg per liter. After dismantling of the test section no scaling products were present. The first experimental test section has now been installed in the loop. The theoretical study on the hydraulic coupling of parallel channels have been continued. (auth)

22483 (GEAP-4798) TWO-PHASE FLOW AND HEAT TRANSFER IN MULTIROD GEOMETRIES. First Quarterly Progress Report, October 26, 1964–January 25, 1965. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1965. 22p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An annular test section for air-water measurements is now ready. Special instruments are being built for flow structure measurements. Thirty-six critical heat flux data

points have been obtained with the nine-rod test section at a pressure of 1000 psia and mass flow rates of 0.3×10^6, 0.5×10^6, 0.75×10^6, 1.0×10^6, and 1.25×10^6 lb/hr-ft^2. The critical heat flux increased with decreasing quality, and with decreasing flow rate for flows less than 0.5×10^6 lb/hr-ft^2. The data are generally higher than single-rod annulus data, particularly at higher steam qualities. (P.C.H.)

22484 (NYO-2765-1) A FUNDAMENTAL STUDY OF HEAT AND MASS TRANSFER IN THE CONDENSATION OF MULTICOMPONENT SYSTEMS. Progress Report. Joseph Estrin (Clarkson Coll. of Tech., Potsdam, N. Y. Div. of Research). Feb. 24, 1965. Contract AT(30-1)-2765. 49p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A paper summarizing work completed during the period concerning a computational technique for mass transfer of vapor mixtures of more than one component is noted but not included; this work is to be published in the A.I.Ch.E. Journal. Summaries of other work during the period are presented. The condensation process in which two condensable components are involved and the mass transfer process consequently involving their partial fractionation are described. A discussion of the Bedingfield correction for the effect of molecular weight difference of the diffusion components upon the mass transfer coefficient leads to its necessary association with the Ackerman factor for the general mass transfer effect. Data from two sets of experiments using different apparatus demonstrate the use of this net corrective factor and also demonstrate the general applicability of the Drew-Colburn mass transfer coefficient for transfer processes in which more than one component transfers phase. The results indicate that the value of the Drew-Colburn coefficient is not seriously affected by molecular-weight differences of the components and by the rate of mass transfer. Research on the effect of mass transfer from a fluid phase on the heat transfer coefficient (and mass transfer coefficient when physical properties vary little) is also described making use of the eddy diffusivity concept. A flat plate is considered over which an incompressible fluid flows; the turbulent boundary layer is steady and well established at the region of interest and mass is being transferred to the solid surface. The Schmidt number or Prandtl number or both are greater than one to the extent that the transfer of heat and mass may be completely described by consideration of the region of flow adjacent to the solid surface in which the effect of the wall is manifest in the momentum transfer process. The vapor velocity parallel to the plate and at some distance from it is greater than the velocity at the interface and directed perpendicular to it. This permits examination of the transfer using well accepted concepts. The flat plate is no great restriction since this geometry when coupled with the above Prandtl number and Schmidt number requirements does not differ in the region of interest because of the momentum transfer process from the round tube geometry. Also, using flat plate geometry permits use of the corresponding equations of motion and continuity which are simpler than those for other geometries. The discussion is concerned with the determination of the mass transfer effect on the transfer coefficients for heat and mass rather than the presentation of absolute profiles, and the results may be considered general within the limitations of straight geometries and Schmidt and Prandtl numbers in the region of unity and greater. (J.R.D.)

22485 EXPERIMENTS ON HEAT TRANSFER TO WIRES IN A PARTIALLY IONIZED ARGON PLASMA. I. Kimura and A. Kanzawa (Tokyo Univ.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 476-81(Mar. 1965).

The heat input rate to wires in a partially ionized atmospheric pressure argon plasma (the degree of ionization is 75% at maximum), of which temperature and stream velocity are known, was measured with an estimated accuracy of ±8%. The thermodynamic and transport properties of atmospheric pressure argon at temperatures below 20,000°K were calculated, taking into consideration the effect of ionization. It was found that the incompressible empirical equations of heat and mass transfer are available for the estimation of the heat input rate in such a high-temperature case. It was also shown by means of probe measurements that the boundary layers in the case of our experiments are near the frozen state and it is probable that the temperature of electrons is higher than that of atoms or ions in the boundary layers. (auth)

22486 HEAT TRANSFER AND PRESSURE DROP OF REACTOR FUEL ELEMENTS WITH POLYZONAL SPIRAL FINNING. N. Afgan and S. Oka. Bull. Boris Kidrich Inst. Nucl. Sci., 15: 97-113(Apr. 1964).

To determine the heat transfer and pressure drop properties and the value and position of the minimum heat transfer coefficient on the polyzonal spiral finning of reactor fuel elements, experiments were made on an open air loop. The range of flow variation was 0.2 to 0.55 kg/sec (Re = 30,000 to 90,000), and the thermal flux from 1.2 to 4.0 kcal/m^{2}sec. The distribution of the St-number over the length and perimeter of the fuel element for different Reynolds numbers and different thermal fluxes was determined. The dependence of the minimum St-number on the Re-number was found: $St = 4.4443 \times 10^{-2} \cdot Re^{-0.2275} \cdot Pr^{-0.6}$. The dependence of the mean St-number on the Re-number was also found, $St = 4.8242 \times 10^{-2} \cdot Re^{-0.227} \cdot Pr^{-0.6}$, along with the dependence of the friction coefficient on the Re-number, $f = 2.0032 \times 10^{-2} \cdot Re^{-0.05354}$. (auth)

22487 MASS TRANSPORT FROM A URANIUM SPHERE TO LIQUID CADMIUM IN HIGHLY TURBULENT FLOW. E. D. Traylor, Leslie Burris, and C. J. Geankoplis (Argonne National Lab., Ill. and Ohio State Univ., Columbus). Ind. Eng. Chem., Fundamentals, 4: 119-25(May 1965).

Mass transfer coefficients from single 0.5-, 0.375-, and 0.25-in. dia spheres of solid uranium to liquid cadmium at 500 to 600°C were measured in the wide Reynolds number region of 80 to 400,000. The dissolution rate of uranium was diffusion-controlled over the entire range. The plot of J_D vs. Reynolds number exhibited a very sharp peak or maximum at a Reynolds number of 70,000. These values of J_D were about 50% lower than those for organics in the low velocity regions. In the high velocity region the values were about the same. Heat-treated uranium spheres with random, fine-grained structures gave J_D values several times greater than spheres with nontreated, coarse-grained structures. (auth)

22488 NUCLEATE BOILING OF HYDROGEN. COMPARISON BETWEEN EXPERIMENTAL AND PREDICTED DATA. D. E. Drayer (National Bureau of Standards, Boulder, Colo.). Ind. Eng. Chem., Fundamentals, 4: 167-71 (May 1965).

Heat flux values predicted by 11 nucleate boiling correlations were compared with experimental data for boiling liquid hydrogen. Three correlations, Forster-Zuber, Forster-Greif, and Cryder-Gilliland, predicted heat flux values in good agreement with the experimental data at temperature differences in the neighborhood of 1°F. Three other correlations, Hughmark, Gilmour, and McNelly, were fair. The correlations of Levy, Jakob-Linke, Isinger-Bliss, Miyauchi-Yagi, and Nishikawa were poor. (auth)

22489 OPTIMUM DIMENSIONS OF UNIFORM ANNULAR FINS. A. Brown (Queen's Univ., Belfast). Intern. J. Heat Mass Transfer, 8: 655-62(Apr. 1965).

An equation was derived relating the optimum dimensions of uniform annular fins to the heat transfer and thermal properties of the fin and the heat transfer coefficient between the fin and coolant. Some computed results covering fairly wide ranges of fin properties and coolant heat transfer coefficients are presented graphically in terms of suitable dimensionless parameters. The choice of parameters made it possible to determine the optimum dimensions of a fin, i.e., the width, length, and volume, in terms of the total heat to be dissipated by the fin, its thermal conductivity, and bore radius, the heat transfer coefficient between the fin and coolant, and the difference in temperature between the fin bore and coolant. The generalized results were applied to a specific example, which showed the effect of material properties upon the optimum dimensions. Finally,

a comparison was made between the optimum dimensions of uniform fins and the dimensions of fins of least material. (auth)

22490 FREQUENCY RESPONSE OF LINEAR COUNTERFLOW HEAT EXCHANGERS. R. K. Thomasson (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Mech. Eng. Sci., 6: 13-25(Mar. 1964).

22491 FREE CONVECTION IN OPEN THERMOSYPHON TUBES OF NON-CIRCULAR SECTION. F. C. Lockwood (Imperal Coll. of Science and Tech., London) and B. W. Martin. J. Mech. Eng. Sci., 6: 379-93(Dec. 1964).

Theoretical and experimental studies were made of laminar and turbulent free convection in the vertical open thermosyphon. Attention was concentrated on the effect of changes in the shape of the cross section on the heat transfer. Two-dimensional theory developed gave a reliable indication of the termination of laminar boundary-layer flow in tubes of rectangular cross section. Detailed measurements illustrated the adverse effects of confined corner regions on heat transfer, particularly in laminar impeded flow. Even with a viscous fluid, confined rectangular sections seemed capable of inducing a complete transition to fully mixed turbulent flow at unexpectedly low Rayleigh numbers. The circular section gave overall heat transfer generally superior to that of any non-circular section in laminar boundary-layer flow. In turbulent flow, at low Rayleigh numbers, unconfined circular and triangular sections provided best heat transfer; at high Rayleigh numbers, for fully developed, fully mixed turbulent flow, their performance was greatly exceeded by that of unconfined rectangular and aerofoil sections. The Nusselt number then increased uniformly with Rayleigh number according to a two-fifths power law usually associated only with turbulent boundary-layer flow. Nusselt numbers of sections of different shape could not satisfactorily be correlated in terms of hydraulic radius, particularly at high Rayleigh numbers. The investigation suggested that hollow gas turbine blades would promote better thermosyphon cooling than blades having circular holes. (auth)

22492 HIGH PRESSURE GAS TUNNEL. H. Grosse and F. Scholz (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 150-8(Apr. 1965). (In German)

A high-pressure test facility for hydrodynamic, thermodynamic, and technological research on spherical aggregates and steam generators for gas-cooled power reactors was built. This facility makes possible experimental studies on larger test objects with measuring sections up to 1 × 1 m under gas conditions up to 40 atm and 400°C. The set-up and its main components are described with particular attention to problems appearing during construction and to methods solving these problems. The normal test run, the measuring equipment, and the evaluation of results are discussed. (auth)

22493 GAS-COOLED FUEL-ELEMENT TEST RIGS. K. H. Presser and F. Scholz (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 158-64(Apr. 1965). (In German)

Three test rigs for experimentation in thermodynamic flow techniques and technological problems concerning gas-cooled fuel-element test rigs were built at the Nuclear Research Establishment, Jülich. The first is a high-pressure test rig for CO_2 and N_2 in which thermal reactor conditions with high Reynolds numbers can be simulated, the second test rig is for air at atmospheric pressure for preliminary experiments, the third is a specialized small test rig for basic research, which forsees the uses of mass transfer analogy. (auth)

22494 PRESSURIZED AND BOILING WATER TEST RIG. H. Barthels, H. Fedders, and F. Scholz (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 164-8(Apr. 1965). (In German)

A test rig for thermodynamic and hydrodynamic studies of water-cooled dummy fuel elements is described. This set-up also makes possible special studies of hydrodynamic conditions at two-phase flow, e.g., with gas-water mixtures. A description of a test section and a detailed explanation of the measuring problems and equipment are included. (auth)

22495 AUXILIARY SYSTEMS FOR THERMODYNAMIC TEST RIGS. K. H. Presser and F. Scholz (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 169-73(Apr. 1965). (In German)

Several centralized auxiliary systems are used for operating large thermodynamic test rigs in the Nuclear Research Establishment, Jülich. These include a closed cooling cycle, plants for the supply with pressurized gases, and a 2-Mw direct-current supply. (auth)

22496 EXPERIMENTAL LOOPS AT NUCLEAR RESEARCH ESTABLISHMENTS. Kerntechnik, 7: 184-5(Apr. 1965). (In German)

Pressurized-water and boiling-water test loops for Nürnberg, an average-pressure gas loop for Ispra, and a high-pressure gas-tunnel for Jülich are described. (M.C.G.)

22497 SOLUTION OF UNSTATIONARY HEAT TRANSFER PROBLEMS FOR HOLLOW CYLINDRICAL BODIES WITH TIME-DEPENDENT ENVIRONMENTAL TEMPERATURE AND SURFACE LOADING. Roman Palinski (EURATOM, Ispra, Italy). Nukleonik, 7: 93-106(Feb. 1965). (In German)

In reactor dynamics, problems of non-stationary heat transfer also occur frequently for hollow cylindrical volumina. The solution of the Laplace-transformed Fourier equation is in general composed of the modified cylinder functions I_0 and K_0. The latter is, however, not eliminated when applying boundary conditions for hollow cylinders. $K_0(s)$ has a logarithmic singularity at $s = 0$ (corresponding to the asymptotic equilibrium for $t \to \infty$ in the real domain), which leads to difficulties for the inverse-transformation. It is shown that only the functions $Z^{s,i}_{m,n} = I_{m,s}K_{n,i} - (-1)^{m+n}K_{m,s}I_{n,i}$ occur in the solution in the complex domain, which no longer have the logarithmic singularity at $s = 0$. Hence, the differential method developed for solid cylinders, can also be applied to hollow cylinders. For this study, it is characteristic that the boundary temperature (the reference value in the boundary condition) should be a function of time. No inner heat source is assumed. The hollow cylinder is thus not a multiplying medium. Instead the heat enters the volume at its inner boundary as a power per surface unit. The boundary conditions chosen and the method of heat supply represent just the cases that occur most frequently when treating cylindrical fuel elements and their claddings. Diffusion problems satisfying the same type of equation can be treated in the same manner. The terminology of heat transfer was chosen because the respective phenomena are more illustrative than those of neutron diffusion. Another problem investigated was that of the relation between an average temperature of the volume and two edge temperatures. Known approximations are, e.g., the arithmetic mean, or, for moving media, the logarithmic mean. However, for non-stationary phenomena, these expressions may be numerically good in some cases, but quite useless in other ones. If the system of ordinary differential equations developed in this paper is used instead of an algebraic relation, the relation between average and edge temperatures can be computed to any required precision, according to the number of equations considered. (auth)

22498 THE PRINCIPLES OF POWER GENERATION. G. E. Kholodovskii. Translated from Fizicheskiye Protessy v Teploenergetike by V. H Brix. A Pergamon Press Book. New York, The Macmillan Company, 1965. 107p.

The principles of energy transfer in conventional electric power stations are outlined, with consideration of the efficiency of a thermal power station. Energy transformations in nuclear power stations are briefly considered. (D.C.W.)

22499 INTERFACIAL HEAT AND MASS TRANSFER IN A SUDDENLY PRESSURIZED, BINARY LIQUID-VAPOR SYSTEM. Wen-jei Yang (Univ. of Michigan, Ann Arbor), P. S. Larsen, and J. A. Clark. New York, American

Society of Mechanical Engineers, 1964, Paper No. 64-WA/Av-1, 6p. (CONF-763-48)

From American Society of Mechanical Engineers Winter Meeting, New York, Nov.-Dec. 1964.

An analysis was made of the phase change across the interface of a suddenly pressurized, binary liquid-vapor system. The time-dependent temperature and concentration distribution, interfacial growth, and the rate of condensation or evaporation at the interface were obtained. Their application is illustrated by representative numerical calculations for the phase change of one and two-component cryogenic systems of nitrogen-nitrogen, oxygen-nitrogen, and helium-nitrogen. (auth)

22500 HEAT TRANSFER TO LIQUID METALS FLOWING TURBULENTLY IN ECCENTRIC ANNULI. W. S. Yu and O. E. Dwyer (Brookhaven National Lab., Upton, N. Y.). New York, American Institute of Chemical Engineers, 1965, Preprint 43f, 52p, $0.50. (CONF-650205-1). (BNL-8497)

From American Institute of Chemical Engineers 55th National Meeting, Houston.

An analytical study was made on heat transfer rates to liquid metals flowing in eccentric annuli. The friction factor, pressure drop, and velocity distribution were calculated. Temperature distributions, including peripheral wall temperature variation, were calculated by two different methods. It was found that eccentricity produced a large amount of temperature variation around the circumferences of both walls. Calculated data are presented in tables and graphs. (M.C.G.)

22501 GRAVITY AS A REMOVAL FORCE IN NUCLEATE BOILING. T. R. Rehm (Univ. of Denver). New York, American Institute of Chemical Engineers, 1965, Preprint 24b, 72p, $0.50. (CONF-650205-2)

From American Institute of Chemical Engineers 55th National Meeting, Houston.

Studies are being made to evaluate the forces acting on a bubble formed in a nucleate boiling situation and to specifically determine the effect of gravity on the forces causing removal of a vapor bubble from a heated surface. Bubbles formed in saturated and subcooled water were photographed in such a manner that the growth velocity and volume could be obtained as a function of time. It was found that three types of bubbles are obtained in subcooled boiling: oscillating bubbles, continuous growth and decay bubbles, and multiple group bubbles containing both oscillating and continuous growth bubbles. It was concluded that actual bubble volume must be used in the calculation of forces acting on the bubble. Data are presented in tables and graphs. They indicate that there does not exist a clear-cut differentiation between bubbles observed at different heat fluxes and subcoolings. It was found that bubbles cannot be assumed to be spherical. Force analysis of saturated bubbles indicated that gravity is a significant removal force. Its absence may prevent bubble separation. Subcooled bubbles exhibited a large positive removal force prior to separation. It was sufficient to cause bubble removal even in the absence of the gravity force. (M.C.G.)

22502 STEAM VOLUME FRACTIONS IN FLOWING AND NON-FLOWING TWO-PHASE MIXTURES. William C. Meyer and John F. Wilson. 5p. (CONF-654-71).

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Tests were conducted to measure the riser void fractions in both flowing and non-flowing two-phase mixtures. A 36-in.-dia by 25-ft tall pressure vessel with a steam flow capacity of 60,000 lb/hr and a pressure rating at 2150 psig was used in the tests. The pressure range was varied from 600 to 2000 psia. In non-flow and flow tests at a constant superficial steam velocity the void fraction increased with increasing pressure. However, the flowing mixture void fractions were lower than the non-flowing mixture voids. An equation was developed for predicting riser voids. Analysis indicated the range of accuracy of the equation is approximately 20%. (M.C.G.)

Materials Testing

Refer also to abstracts 22660, 22922, 22995, 23581, and 24090.

22503 (GAMD-5503) PLEXIGLAS MODEL OF A THICK-WALLED VESSEL: EXPERIMENTAL AND NUMERICAL ANALYSIS. C. Riparbelli (General Atomic, San Diego, Calif.). Aug. 31, 1964. 22p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

The results of stress and strain analyses performed on a small model of a thick-walled pressure vessel are reported. The model was not a scale model of a real vessel. The thickness/ratium ratio was larger than in any of the concrete vessels under design. The model was instrumented with strain gages and tested under internal pressure. A numerical stress analysis was done as an application of an IBM code entitled TARGET specifically written for the analysis of thick-walled bodies of revolution. Another stress analysis was done by means of a code based on thin-shell theory. Comparison of the surface strains computed by means of the TARGET code with those measured in the tests showed good agreement, except for the longitudinal strains at the inner surface. There the experimental values were displaced toward the negative side by an almost uniform amount. A temperature-induced bias of the experimental values is offered as a tentative explanation for this discrepancy. (P.C.H.)

22504 (HW-SA-3469) SCINTILLATION AND NEUTRON FISSION TECHNIQUES FOR NONDESTRUCTIVE TESTING OF LOW-LEVEL URANIUM CONTAMINATION ON N REACTOR FUEL. Charles N. Jackson, Jr. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Mar. 1965. Contract AT(45-1)-1350. 33p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A tester was developed and fabricated that detects the alpha decay from ^{238}U and ^{234}U. It was used to measure fuel element uranium surface contamination of 10 to 100 μg as a production line test. It contains a zinc sulfide scintillation system that can test a 118 $in.^2$ surface at one time. In a 13 minute test, it was used to measure the quantity of contamination with an estimated accuracy of ±25% at 100 μg. The alpha count rate is from 0.4 to 0.7 counts/min/μg from the uranium depending on the size of the area being tested. It was also used to pinpoint manufacturing operations that had resulted in uranium contamination of N-Reactor fuel elements. Cladding with up to 100 μg of contamination was traced to oxidation testing in a specific autoclave. Fuel end caps with up to 300 μg of contamination were traced to the end cap assembly operation. The tester was used to investigate the effects of various parameters in both of these operations. It was found that it has potential for greater throughput by use of a go, no-go mode of operation that would shorten the test time to 6 min or less. It was possible to achieve needed sensitivity and microscopic detail by the use of the neutron fission technique. Accurate measurements were obtained in the 2,000 to 20,000 ppm range. The plastic detector proved much easier to use than the mica because the tracks are easier to see and count. Scanning to locate contaminated areas can be accomplished at 10 × magnification with the plastic whereas the mica required 100 ×. This technique, though not developed to the status of a production test, is at the very minimum an excellent backup test for the alpha counting technique. The neutron fission technique has excellent capabilities for future growth because of its potentially greater sensitivity which can be achieved simply by increasing the size of the neutron dose. (P.C.H.)

22505 (KAPL-M-6195) PLEXIGRAM — A PIPING FLEXIBILITY ANALYSIS PROGRAM. B. A. Gottschalk, D. L. McCullough, and J. R. Schmid (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 15, 1965. Contract W-31-109-eng-52. 76p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

PLEXIGRAM is a digital computer program for the analysis of stresses and deflections in three-dimensional piping configurations. The program is able to solve simple,

single branch systems; open and closed piping loops; multi-branch systems; and up to three coupled systems. Piping supports are also allowed. PLEXIGRAM computes and edits reactions, stresses, and deflections of the piping system. The transformation matrices, integrated member flexibilities, and stiffness matrices for each branch are available as optional output. Limitations of the program are listed. The running time for the program is dependent upon the size of the piping configuration: number of loops, branches, and systems. A system composed of one seven-member branch averages about 30-40 seconds of machine time on the Philco-2000-212 computer. (auth)

22506 (NP-14968) NON-DESTRUCTIVE ANALYSIS OF IRRADIATED FUEL ELEMENTS. Final Report. P. Kristiansen and T. Roegeberg (Institutt for Atomenergi, Kjeller (Norway)). [1959]. 112p. Dep.(mn).

Includes 3 Quarterly Progress Reports.

Feasibility studies on two approaches to the problem of non-destructive analysis of fuel elements from a nuclear reactor are described. In the first method an attempt was made to measure the intensity of the Kα lines from Pu, relative to those of U, using a crystal spectrometer. In this way the Pu content of the fuel is measured. In the second method the gamma spectrum from fuel samples was measured using a scintillation spectrometer. By this, the content of the isotope ^{137}Cs is determined, and, thereby, the burnup of ^{235}U. Measurements were performed on two slugs from fuel elements taken out of the reactor JEEP at IFA. Using the first method it was concluded that it is possible to use a crystal spectrometer of simple design to resolve the Kα radiation of Pu and U. With the second method the burnup of ^{235}U was determined within an error of 35%. By improving the experimental conditions as to background, etc., it is believed that the Cs content could probably be determined with an accuracy of 10–15%. (P.C.H.)

22507 (ORNL-P-1109) NONDESTRUCTIVE TESTING OF IRRADIATED MATERIALS IN THE UNITED STATES. Robert W. McClung and Donald A. Douglas, Jr. (Oak Ridge National Lab., Tenn.). [1965]. Contract [W-7405-eng-26]. 16p. (CONF-650604-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

For presentation at International Symposium on Working Methods in High Activity Hot Labs., Grenoble, France.

New demands for nondestructive evaluation of radioactive specimens in high-activity hot laboratories have required extensive development of new techniques. Several methods using external radiation sources have needed greater development beyond that necessary for cold laboratory operation. Radiation techniques which are discussed include neutron radiography, x-radiography, gamma attenuation, and the use of x-ray sensitive television. Many other methods such as ultrasonics, eddy currents, liquid penetrants, and leak testing have been possible by making mechanical modifications to allow the test to be performed remotely. (auth)

22508 (ORNL-P-1188) NONDESTRUCTIVE TESTING TECHNIQUES FOR RESEARCH AND PROCESS CONTROL. D. A. Douglas, Jr., R. W. McClung, B. E. Foster, and C. V. Dodd (Oak Ridge National Lab., Tenn.). [1965]. Contract [W-7405-eng-26]. 27p. (CONF-650511-1). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

From Symposium on Non-Destructive Testing in Nuclear Technology, Bucharest.

Three recent examples of the evolution of nondestructive testing techniques from research to process control are reported. A current fuel element design contains fuel pins filled with vibratorily compacted uranium and thorium oxide powder. A gamma attenuation technique was developed to allow measurement of the homogeneity of fuel loading and was used to aid development of fabrication techniques and equipment. Later an inspection device was built to operate remotely in a hermetically sealed and shielded facility and used for production process control. Another fuel element required fuel plates containing a uranium oxide-aluminum dispersion core with a programmed variation in the fuel loading across the width. A continuous scanning, x-ray attenuation technique was developed and used to measure fuel inhomogeneities and conformity to design contour. The technique assisted the development for both core pressing and plate rolling practices. A system was constructed for rapid automatic evaluation of production fuel plates. Another approach to fuel elements is the use of minute fuel-bearing particles coated with pyrolytic carbon to retain the fission products. Of concern are the core diameter, coating thickness and integrity, and presence of fuel in the coating. Development of microradiographic techniques provided a powerful tool to evaluate the many variables in the coating process for optimum fabrication. Further application allows evaluation of the effects of service including heat treatment and in-reactor testing. (P.C.H.)

22509 (PWAC-123) FLEXIBILITY AND STRESS ANALYSIS OF A NaK PIPING SYSTEM FOR A NUCLEAR-POWERED AIRPLANE. A. W. Starbird (Pratt and Whitney Aircraft, East Hartford, Conn.). Nov. 17, 1954. Contract [AT(11-1)-229]. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A flexibility and stress analysis was performed for two NaK piping systems installed in an airplane configuration described in the Convair Report CVAC-201 "Tactical Nuclear Powered Airplane Evaluation." The two systems handle NaK flow rates of 300 and 700 lb/sec/engine. Based on a NaK velocity of 25 ft/sec, the pipes have inside diameters of 7 in. and 10.7 in., respectively. The assumed pipe material is 316 stainless steel. Pipe line configurations were found that maintain pipe stresses and anchor reactions within acceptable limits. In the cold condition pipe stresses are due to internal pressure and cold springing of the lines; whereas in the hot condition stresses are due to internal pressure and inertial loadings. Stresses due to thermal expansion are eliminated in the hot condition by a combination of cold springing and axial engine movement with respect to the reactor. The total weight of the piping and contained NaK is 1,875 lb/engine for the 7 in. ID pipe and 4,900 lb/engine for the 10.7 in. ID pipe. These weights are excessive, and future analyses will attempt to produce significant reductions by increasing the NaK velocity and/or adopting a stronger pipe material. NaK pressure drops through the various pipe sections were calculated. Estimates were made of the natural frequencies of the pipe lines by experimentally determining the natural frequencies of models of the pipes. The natural frequencies are between 16 and 20 cps for all lines. (auth)

22510 (SC-DC-65-1123) NEW FRONTIERS FOR NONDESTRUCTIVE TESTING IN THE NUCLEAR AGE. Douglas W. Ballard (Sandia Lab., Albuquerque, N. Mex.). [1965]. Contract AT(29-1)-789. 19p. (CONF-650509-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From IAEA Symposium on Nondestructive Testing in Nuclear Technology, Bucharest.

Predictions of seven new frontiers for nondestructive testing are discussed. These new frontiers include: material properties testing; research and development tools; dynamic NDT applications; multiple nondestructive testing; electronic component and systems testing; infrared tests; and microwave tests. Examples are given to reinforce each prediction. (P.C.H.)

22511 FUEL UNIFORMITY IN SANDWICH PLATES. P. De Meester, M. J. Brabers, and R. Deknock (SCK/CEN, Mol, Belg.). Brit. J. Non-Destructive Testing, 6: 123-9 (Dec. 1964).

A batch of 375 fuel plates was tested for uniformity of the fuel after rolling. Simultaneous measurements were made of gamma and beta emission to determine the total amount of ^{235}U and the cladding thickness. Deviations from the mean uranium content as high as 25% were found. A heterogeneity was also observed in the direction perpendicular to the rolling direction, amounting to up to 10% of the mean value. The core of the plates is a ~24% U–Al alloy with 90% enriched uranium. The cladding is aluminum. In the procedure adopted, a counting time of 10 sec

was chosen, resulting in an error of ±1.5% on a 95% confidence level. (M.C.G.)

22512 APPLICATION OF GAMMA SCINTILLATION SPECTROMETRY FOR INSPECTION OF FUELS. Hideo Yamaki and Yutaka Fukushima (Hitachi Ltd., Tokyo). Hitachi Hyoron, 46: 429-34(Mar. 1964). (In Japanese)

Gamma scintillation spectrometry was applied to nondestructive, simple, and rapid inspections of nuclear fuels. One application was the measurement of the U-235 enrichment factor by comparing the sum of the intensities of 93-kev gamma rays from Th-234, the daughter nuclide of U-238, and 94-kev gamma rays from U-235 with the intensity of 184-kev gamma rays for U-235. An empirical equation, valid under the experimental conditions, was derived, which relates the gamma-ray intensities to the enrichment factor. No effect of the particle size of the UO_2 powder was observed at 0.1–100 microns. The other application was the measurement of uranium distribution in fuel elements by radiography. The packing density for a vibration-packed UO_2 fuel rod was determined, using Cs-137 as the radiation source. The error was within 1–1.5% at the measuring speed of 2 cm/min. Natural U–Al alloy fuel plates were also examined by this method using Tm-170. Autoradiography of the same alloy plates was not successful because of the large self-absorption and small amount of gamma rays from natural uranium. (NSA of Japan)

22513 MEASURING AND CONTROL EQUIPMENT FOR LARGE THERMODYNAMIC TEST RIGS. A. Hellwig and Th. Overhoff (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 173-9(Apr. 1965). (In German)

Measuring and control equipment for thermodynamic test rigs are described. The aim was to obtain the accuracy and objectivity necessary for scientific evaluation using units manufactured industrially with only several small alterations, but intensive testing during operation. (auth)

22514 A CONTINUOUS X-RAY SCANNING TECHNIQUE FOR DETERMINING MINUTE INHOMOGENEITIES IN SOLIDS. B. E. Foster, S. D. Snyder, and R. W. McClung (Oak Ridge National Lab., Tenn.). Mater. Evaluation, 23: 191-5(Apr. 1965). (ORNL-P-54)

A continuous x-ray scanning attenuation technique was developed for homogeneity evaluation. The theory of the technique and equipment used in it are described. One homogeneity problem for which this system was used involved a fueled cross section of U_3O_8 in aluminum resembling an airfoil. The system accuracy and reproducibility was on the order of 1% as measured over the past year. (M.C.G.)

22515 EXPERIMENTAL X-RAY STRESS ANALYSIS PROCEDURES FOR ULTRA HIGH STRENGTH MATERIALS. H. R. Woehrle, F. P. Reilly, III, W. J. Barkley, III, L. A. Jackman, and W. R. Clough (Rensselaer Polytechnic Inst., Troy, N. Y.). 24p. (CONF-715-9).

From 13th Annual Conference on Applications of X-Ray Analysis, Denver, Aug. 1964.

The development and evaluation of workable x-ray stress analysis procedures for measuring, with a good degree of accuracy, high elastic strains are discussed. The materials selected include Maraging steels, ausformed steels, and cold drawn AISI 4340 steels. Of the various possible x-ray techniques considered, very satisfactory results were obtained by the use of the two-exposure method. A special fixture was designed and constructed to allow uniaxial straining of test specimens while in the x-ray unit. Imposed strains were measured directly by strain gages mounted on the specimen. Simultaneously, strains were measured by the use of chromium radiation filtered with vanadium foil. The peak resolution obtained was very satisfactory with a peak to background ratio of approximately 4:1 for the {211-121} martensite doublet used to measure the shift in peak location between the normal and oblique exposures. Because of the widths of the peaks involved, it was impossible to precisely specify the angular position of a given peak by inspection of the usual recorded trace. A counting technique, combined with a least squares curve fitting procedure involving five points, was very satisfactory for precisely locating positions of maximum intensity. Even better results were obtained when a multiplicative correction factor proposed by Koistinen and Marburger was applied. (auth)

22516 NONDESTRUCTIVE TESTING OF BERYLLIUM. C. J. Havel and W. O. Frauson (Beryllium Corp., Reading, Penna.). 21p. (CONF-729-22)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

The two chief methods for nondestructive testing of beryllium are liquid penetrant for surface discontinuities and radiography for internal integrity. Because beryllium is extremely transparent to x rays, the radiographic techniques used are important. In general, best results were obtained using equipment with low voltage, small focal spot, and very low tube filtration. The most suitable films were found to be fine grain-high contrast films packaged in disposable paper holders. These were then processed to the highest film density possible for use with available film viewing equipment. Material quality ratings are based on the total combined volumes of all inclusions present in a cubic inch of material. Ultrasonic inspection of beryllium is not used much except when neither penetrant testing nor radiography can be performed. (M.C.G.)

Protective Structures

Refer also to abstract 22591.

22517 (USNRDL-TR-647) THE DESIGN AND PERFORMANCE OF A FALLOUT-TESTED MANNED SHELTER STATION AND ITS SUITABILITY AS A SINGLE-FAMILY SHELTER. J. D. Sartor, P. D. LaRiviere, H. Lee, and J. I. Pond (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 23, 1963. 61p.

The design details, cost analysis, and performance characteristics are presented for small, partially-underground fallout shelters utilized as manned stations during a nuclear weapon effects test. Four men occupied each shelter and operated radiation measurement and fallout collection instruments. Two types of shelters were designed to withstand predicted overpressures: Type I for a 1-psi overpressure and Type II for a 5-psi overpressure. The basic structure consisted of an 8-ft diameter, 10-ft long, 12-gage corrugated steel, multi-plate pipe. A steel entranceway incorporating two right-angle turns provided access to the basic structure. Depending upon the amount of soil backfill, fallout gamma radiation protection factors up to 470,000 were obtained. The overall performance of the shelters under the conditions experienced was excellent. It is suggested that shelters of this type have application not only for use as manned stations in nuclear weapon testing but can be adapted as well for use in residential areas as single-family fallout shelters. (auth)

Space Propulsion

See also REACTOR TECHNOLOGY — Propulsion and Space.

22518 (NASA-TN-D-2172) STATUS OF ELECTROSTATIC THRUSTORS FOR SPACE PROPULSION. William R. Mickelsen and Harold R. Kaufman (Lewis Research Center, National Aeronautics and Space Administration, Cleveland, Ohio). May 1964. 128p. (N64-19477). $2.75 (CFSTI).

Research programs are described for electron-bombardment thrustors, contact-ionization thrustors, and colloidal-particle thrustors. The critical component in the electron-bombardment thrustor is the cathode, and data indicate that durable low-power cathodes can be developed. The per-

formance of the contact-ionization thrustor is limited by porous-tungsten technology. Colloidal-particle thrustors are still in the research stage but appear to have the best promise for high efficiency at low specific impulse, low mass, and programmed specific impulse operation. (auth)

22519 RESEARCH ON CHARGED COLLOIDAL PARTICLE PROPULSION. S. P. Harris (Maremont Corp., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-72, 12p, $1.00. (CONF-650108-12)

From AIAA 2nd Aerospace Sciences Meeting, New York.

Using a cold cathode type ion source and a colloidal carbon feeding device, a beam of charged colloidal carbon particles was produced and measured. The beam was collected on a collecting electrode and at the same time a sample of the carbon particles striking the electrode was taken using a greased glass strip mounted on the collector to catch and hold the carbon particles. Photomicrographs of the carbon particles adhering to the grease were taken. The charge-to-mass ratio for the charged colloidal carbon was computed and also the thrust exerted by the beam was figured. Direct measurement of beam thrust for colloidal carbon beams of a few microamperes by a ballistic pendulum method appears feasible. The mechanisms of producing charged colloidal particles in the ion source, including secondary electron emission, ion capture, X-ray photoelectric effect and Compton scattering are discussed. (auth)

22520 EXHAUST OF A PINCHED PLASMA FROM AN AXIAL ORIFICE. Robert G. Jahn, Woldemar von Jaskowsky, and Rodney L. Burton (Princeton Univ., N. J.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-92, 16p, $1.00. (CONF-650108-10)

From AIAA 2nd Aerospace Sciences Meeting, New York.

The ejection of a plasma from an orifice in the chamber in which it is generated is studied experimentally in a large-radius, linear-pinch discharge. Plasma created by the radial implosion of the discharge current sheet is allowed to exhaust axially through various diameter central orifices into a large coaxial pyrex vessel. The development of the exhaust plume, and the preceding development of the discharge within the chamber near the orifice, are examined by Kerr-cell and streak photography, and by a series of magnetic probe traverses of the same region, for ambient argon pressures from 30 μ to 1920 μ. It is found: that the exhaust speed, and the persistence of the plume in the axial outward direction are more sensitive to the throat diameter of the orifice than to the details of its axial contour; that the exhaust speed and persistence are optimized at orifice diameters many times larger than the minimum diameter of the pinched plasma column; that the axial exhaust speed may be a large fraction of the preceding current sheet speed within the chamber; that the development of the discharge within the chamber is essentially undisturbed by the presence of a large orifice in the electrode; that for the larger orifices, the original interior luminous front diffracts through the aperture, and then propagates outward, both radially and axially into the exhaust chamber prior to the ejection of the pinch-heated plasma; and that these diffracted fronts are accompanied by corresponding profiles of current density and interior magnetic fields within the exhaust plume. (auth)

22521 EFFECTS OF RELIABILITY CONSIDERATIONS ON THE DESIGN OF ELECTRIC THRUSTOR ARRAYS. J. H. Molitor, K. R. Pinckney, and R. L. Seliger (Hughes Research Labs., Malibu, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-68, 41p, $1.00. (CONF-650108-15)

From AIAA 2nd Aerospace Sciences Meeting, New York.

The effect of power conditioning and ion thrustor module size and number are evaluated in terms of reliability. The necessary mathematical models required to compute power conditioning and ion thrustor system reliabilities are presented. An optimization study is performed to determine the degree of redundancy required for power conditioning circuits and the optimum number of ion engine modules and standbys required to obtain the requisite system reliability for least increase in system specific weight. (auth)

22522 THE DESIGN AND PERFORMANCE OF SASTRUGI ION OPTICAL SYSTEMS. S. L. Ellenberg, E. Caplinger, H. Daley, J. Perel, and W. Seitz (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-69, 15p, $1.00. (CONF-650108-14)

From AIAA 2nd Aerospace Sciences Meeting, New York.

A technique for simultaneously optimizing ion engine geometry with respect to perveance and electrode clearance is described. The method uses both an electrolytic tank and a digital computer. The electrolytic tank is used to roughly determine emitter geometry. Shapes which appear to offer a high degree of uniformity of current density are then completely evaluated by digital computer techniques. The major portion of the emitter possesses axial symmetry for which the cesium flow distribution may be evaluated numerically. The distribution near the edges of the emitter which deviates from axial symmetry is determined by solving the diffusion equation with a resistance paper study. The values of cesium flux computed by these methods then become the initial conditions on current densities for the numerical computation of emission limited trajectories. The resulting optical characteristics for a new design are compared with previous Sastrugi designs. In order to achieve correlation between the above study and actual engine operating conditions, data from an experiment utilizing a Faraday cup probe traversing the beam are presented. (auth)

22523 EXPERIMENTAL PROPULSION PERFORMANCE OF A LOW POWER PULSED RESISTOJET. S. Bennett, W. Huss, R. R. John, and A. Tuchman (AVCO Corp., Wilmington, Mass.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-97, 26p, $1.00. (CONF-650108-6)

From AIAA 2nd Aerospace Sciences Meeting, New York.

Experimental results on a fast heatup resistojet suitable for the attitude control and station keeping of a 500 lb synchronous satellite are presented. The resistojet consists of a thin-wall tubular heating element with a small exit nozzle. The size of the heater element has been minimized to permit rapid heatup with small energy expenditure. Engine performance data have been obtained with a direct force measurement thrust stand. Preliminary results obtained using a molybdenum heater tube indicate thrust levels of the order of 0.3 mlb at slightly less than 200 second specific impulse with an electrical input power of ~20 watts and an ammonia flow rate of $\sim 1.5 \times 10^{-6}$ lb/sec. It is anticipated that operation with a tungsten tube heater element and ammonia as a working fluid will lead to specific impulses close to 250 seconds at the 1 mlb thrust level, with the obtainable specific impulse decreasing somewhat at lower thrust levels. These results suggest that the low-power resistojet compares favorably with other electric and chemical propulsion systems for long-term (greater than one year) attitude control and station keeping of satellites in the 500 to 1500 lb class. (auth)

22524 TESTING REQUIREMENTS OF ELECTRIC PROPULSION SYSTEMS LEADING TO EXTENDED FLIGHT-TIME MISSIONS. J. W. Stearns (California Inst. of Tech., Pasadena). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-67, 21p, $1.00. (CONF-650108-16)

From AIAA 2nd Aerospace Sciences Meeting, New York.

Test requirements for long-life electric-propulsion subsystems, together with the minimum test program to be accomplished prior to acceptance of electric propulsion for mission spacecraft design, are outlined. Spacecraft subsystem interactions with other spacecraft subsystems are dedined. Comparisons are made between laboratory test and flight test programs by which the required system performance data may be obtained. Analysis indicates that, as lifetime requirements are extended into the 10,000- to 30,000-hour range, flight testing becomes more desirable relative to laboratory testing for a large class of component and subsystem tests. Flight testing is also required to eval-

uate most spacecraft integration problems. A flight-test program must fit within the constraints of current resources and requires a high level of interagency coordination in the field of space flight. (auth)

Vacuum Engineering

22525 PHOTODESORPTION OF CARBON MONOXIDE. W. J. Lange (Westinghouse Research Labs., Pittsburgh). J. Vacuum Sci. Technol., 2: 74-9(Mar.-Apr. 1965).

The desorption of carbon monoxide from surfaces in a vacuum under photon irradiation was studied. As the coverage on tungsten approaches completion, thermal desorption from a very weakly bound phase dominates. Negligible photodesorption from quartz is found. Desorption from borosilicate glass is found to be dependent upon the CO pressure and history. (auth)

22526 HANDBOOK OF VACUUM PHYSICS. VOLUME 3. TECHNOLOGY. A. H. Beck, ed. PART 1. CERAMICS AND CERAMIC-TO-METAL SEALING. PART 2. SOLDERING AND BRAZING. W. H. Kohl. PART 3. HIGH FREQUENCY HEATING. D. I. Spash. A Pergamon Press Book. New York, The Macmillan Company, 1964. 199p.

Properties of ceramics and ceramic to-metal sealing are discussed. Soldering and brazing are described. Generation and applications of high-frequency power for heating are considered. (M.C.G.)

22527 AN EXPERIMENTAL VACUUM SYSTEM USING CRYOPUMPING. R. David and A. Venema (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). 8p. (CONF-640903-13)

From American Vacuum Society Symposium, Chicago.

Cryopumping experiments are described. The machine used for producing the low temperatures for the walls and parts of the vacuum system is the cold-gas-cooling machine based on the Stirling cycle. Small metal vacuum systems were built, the walls of which were in direct thermal contact with the cold parts of the cold-gas-cooling engine. Pressures below 10^{-9} Torr could be obtained easily within one hour of operation. The cooling machine allows heating of the vacuum chamber just by reversing the direction of rotation. (M.C.G.)

GEOLOGY AND MINERALOGY

General

22528 (AD-607367) GROUND MOTIONS RESULTING FROM NUCLEAR SURFACE DETONATIONS. R. E. Hutton (Space Technology Labs., Inc., Los Angeles, Calif.). Feb. 1960. 50p. (STL-TN-60-0000-09099). $2.00(CFSTI).

A mathematical model that can, for most cases of practical interest, provide a reasonable approximation of both vertical and horizontal ground shock spectra. Results obtained from the model were compared with limited experimental results and were found to be in reasonable agreement. The results also indicated that the ratio of air pulse speed to soil seismic speed is one of the most important parameters of the phenomenon and may grossly affect the ground response and, thereby, the response of a structure attached to the ground. (P.C.H.)

22529 (IDO-22046) HYDROLOGY OF SUBSURFACE WASTE DISPOSAL NATIONAL REACTOR TESTING STATION, IDAHO. Annual Progress Report, 1963. D. A. Morris, W. E. Teasdale, et al. (Geological Survey, Idaho Falls, Idaho). May 1964. 228p. Dep.(mn); $6.00(cy), 5(mn) CFSTI.

Results of investigations of the NRTS geological area are presented. Special studies are reported concerning waste disposal. It was found that ground water underlying NRTS is part of the larger ground-water body underlying the entire Snake River plain. NRTS is underlain by basalt and unconsolidated sediments. Study during 1963 was devoted to determining chemical or radiometric changes that occurred as ground water containing radioactive waste moved through the geologic environments underlying the NRTS area. Results of water level studies and test hole sample analyses are included. (J.R.D.)

22530 (UCRL-7787) NUCLEAR EXPLOSION CRATERS, ASTROBLEMES, AND CRYPTOEXPLOSION STRUCTURES. Nicholas M. Short (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 24, 1964. Contract W-7405-eng-48. 75p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The nature of a contained nuclear explosion is briefly reviewed. The mechanics of nuclear crater development are then compared with the mechanics of impact cratering. Both similarities and differences between nuclear and impact craters are defined. Reasons for the presence or absence in nuclear craters of certain shock-induced features associated with astroblemes are examined. Shatter cones and coesite-stishovite, indicators of the action of shock pressures, are rarely found in nuclear craters. Micromechanical effects such as extension fractures, twinning, kink bands, strain shadows, and reduced birefringence are especially indicative of intense shocks above 50-100 kilobars. Several possible phase transformations, not yet observed in rocks shocked by either nuclear or impact loading, are considered in light of experimental evidence and theoretical predictions. Other aspects of shock effects in rocks, including physical property variations, solid state changes, and formation of glass from shock-melted materials, are discussed. By combining features observed in nuclear craters with those found at impact craters, a set of diagnostic criteria is specified for recognition of astroblemes. Lack of coesite, shatter cones, and micromechanical effects in many supposed astrobleme structures, especially ancient ones, is explained by an interpretation of Bjork's analysis of impact crater mechanics. This suggests that most of the rocks experiencing high pressures in the line of penetration are removed as throwout. Finally, the possibility that strong subterranean explosions in the earth's crust have produced large shock deformations is rejected for lack of evidence or adequate mechanisms. (P.C.H.)

22531 VARIATION OF PARTITION COEFFICIENT. Akimasa Masuda (Tokyo Univ.). Nature, 205: 1098-9 (Mar. 13, 1965).

Previously determined partition functions for the lanthanides are discussed. The uncertainty as to whether the partition functions so far obtained for elements other than lanthanides are for the pure magnesium effect or for a combined effect of magnesium and calcium is pointed out, and it is suggested that the lanthanide partition functions be reinvestigated. (C.E.S.)

Natural Radioactivity and Fallout

Refer also to abstracts 21811, 21829, and 21841.

22532 (AE-171) MEASUREMENTS OF BACKGROUND AND FALL-OUT RADIOACTIVITY IN SAMPLES FROM THE BALTIC BAY OF TVÄREN, 1957–1963. P. O. Agnedal (Aktiebolaget Atomenergi, Stockholm (Sweden)). Jan. 1965. 48p. Dep.(mn)

Studies were made on the radioactivity of biological samples in the Baltic Bay of Tvären. Correlation between radioactivity in fallout and that in flora and fauna is given. The contribution of natural activity from the radionuclide ^{40}K was determined and is given for all samples, including water, plankton, mollusks, crustaceans, and fish. In some samples from different groups the content of ^{90}Sr and ^{137}Cs was measured. Some gamma spectrograms were taken in order to determine other nuclides. Data on ash weight expressed in percent of wet and dry weight are tabulated. (P.C.H.)

22533 (ANL-6839(p.79-84)) Cs^{137} TRENDS IN HUMANS FROM 1955 TO 1964. C. E. Miller (Argonne National Lab., Ill.).

Whole-body measurements of ^{137}Cs and ^{40}K content have been made periodically since 1955 on a group of normal individuals. The results of individual measurements of 5 subjects from 1955 to 1964 and of 5 additional subjects from 1957 to 1964 are presented. Analyses of these measurements demonstrated that the short-term variations of ^{137}Cs in an individual reflect his dietary habits for that period rather than the general fallout level and that ^{137}Cs content, as well as body K, decrease with a decrease in food intake and a corresponding weight loss. The average ^{137}Cs content of the group increased from March 1955 to May 1956, remained constant until May 1957, when it increased to a maximum in June 1959, decreased until Oct. 1961 and remained constant until Dec. 1961, increased during 1962 and reached a new maximum in mid 1964, which was twice that of mid 1959. The ^{137}Cs content is apparently decreasing. (C.H.)

22534 (EUR-2220.f) NIVEAUX DE CONTAMINATION RADIOACTIVE DU MILIEU AMBIANT ET DE LA CHAINE ALIMENTAIRE. Rapport annuel 1963. (Radioactive Contamination Levels in the Environment and in the Food Chain. Annual Report, 1963). (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre de Études Nucléaires). 1965. 56p. Dep.(mn).

Progress is reported in studies on the radioactive contamination of the environment and of food chains in countries of the European Atomic Energy Community during 1963. Nutrition surveys were made at representative locations and data were compiled on the consumption of milk and other foodstuffs by various age groups. The radioactivity of various foods was determined with emphasis on the content of ^{137}Cs and ^{90}Sr. Iodine metabolism in children and problems connected with the gastrointestinal tract during growth were studied. Calculation techniques were developed and studies were made on the numerical processing of biological data. (C.H.)

22535 (HW-SA-3487) DISTRIBUTION OF Na^{22} AND Cs^{134} IN FALLOUT, FOODS AND PEOPLE. R. W. Perkins and J. M. Nielsen (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 22, 1964. Contract AT(45-1)-1350. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Air concentrations of ^{22}Na and ^{134}Cs were measured at selected locations in Alaska, California, Idaho, Oregon, and Washington during 1962 and 1963 and their fallout rates compared with that of ^{137}Cs. Measurements of these radionuclides in various foods and bioassay samples permit a comparison of the route by which the cosmic ray produced ^{22}Na enters man with that of the cesium radionuclides, and compares the ^{22}Na body burdens of people in Washington State with the Alaskan Eskimos. (C.H.)

22536 (NRL-6229) DETERMINATION OF RADON CONCENTRATION IN THE AIR THROUGH MEASUREMENT OF ITS SOLID DECAY PRODUCTS. L. B. Lockhart, Jr., R. L. Patterson, Jr., and C. R. Hosler (Naval Research Lab., Washington, D. C.). Mar. 29, 1965. 30p. $1.00 (CFSTI).

An analytical method was devised for the determination of the radon concentration in the air by measurement of the radioactive decay of the solid radon daughters collected on air filters during a fixed sampling period. The ratio of the radioactivity present at two periods, determined by an initial count immediately after termination of sampling and a second count an hour later, was used to estimate the extent of radioactive equilibrium established between radon and its daughters and to obtain a correction factor for relating radon daughter activity to radon activity. The disintegration rates of the various decay products of radon as a function of the age of the radon conglomerate were calculated during the growth and collection periods and for successive 5-minute decay periods extending through the first 71 minutes following termination of filtration. A procedure for the calibration of β counters for the evaluation of RaB and RaC activities was established. Use was made of this analytical method to determine radon concentrations in the air near ground level. (auth)

22537 (TID-21522) THE GEOCHEMISTRY OF PROTACTINIUM-231 AND THE DATING OF PELAGIC SEDIMENTS. Annual Report. William M. Sackett, Wallace S. Broecker, and David L. Thurber (Lamont Geological Observatory, Columbia Univ., Palisades, N. Y.). Feb. 1965. Contract AT(30-1)-3139. 49p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Papers are included on sediment deposition rate determination by the protactinium method and on measured rates of marine sediment deposition and implications for accumulation rates of extra-terrestrial dust. Separate abstracts were prepared for these papers. A paper on U and Th series nonequilibrium in sea water was previously abstracted in NSA; see 19: 9380. (J.R.D.)

For abstracts of individual papers see: 22538 and 22539.

22538 (TID-21522(A1-19)) DEPOSITION RATES BY THE PROTACTINIUM METHOD. (Lamont Geological Observatory, Columbia Univ., Palisades, N. Y.).

Results are presented of analyses of five deep sea drill cores chosen to represent various sediment types and ocean basins. Core data are tabulated on ^{231}Pa leaching, $CaCO_3$ content, and age. Data are also included on accumulation rates of ^{230}Th and ^{231}Pa in the specimens. Results of the investigation indicate that the ionium method may be unreliable and that the Pa method is more dependable. (J.R.D.)

22539 (TID-21522(B1-14)) MEASURED DEPOSITION RATES OF MARINE SEDIMENTS AND IMPLICATIONS FOR ACCUMULATION RATES OF EXTRA-TERRESTRIAL DUST. William M. Sackett (Lamont Geological Observatory, Columbia Univ., Palisades, N. Y.).

Results of measurements indicate that the average accumulation rate of extra-terrestrial material over the past few thousand years is less than or equal to $0.1/cm^2/1000$ yr. Based on the estimate of 10^4 tons cosmic dust being added to the earth daily, one per cent or less of marine sediments has cosmic origin. (J.R.D.)

22540 GAMMA SPECTRA OF RADIOACTIVE PRECIPITATIONS AND THEIR VARIATION WITH TIME. K. Haberer (Technische Hochschule, Karlsruhe, Ger.). Atomkernenergie, 10: 69-73(Jan.-Feb. 1965). (In German)

An attempt is made to predict mathematically the gamma spectra of radioactive precipitations using the known data on the composition of the radionuclide mixture from the fission process and on the decay schemes of the individual fission nuclides in dependence on their age, in reference to the time elapsed since the fission occurred. The calculations are valid for customary NaI(Tl) well-type crystals of sizes from 2in. × 2 in. to 3 in. × 3 in. The results are presented in a number of graphs in which the contribution of the nuclides to the individual peaks can be seen, as well as the change of the absolute and relative (compared to the 0.5-Mev peak) counting rates of the photopeaks and the relative peak heights. (auth)

22541 THE ISOTOPIC COMPOSITION OF STRONTIUM IN SURFACE WATER FROM THE NORTH ATLANTIC OCEAN. G. Faure (Ohio State Univ., Columbus), P. M. Hurley, and J. L. Powell. Geochim. Cosmochim. Acta, 29: 209-20(Apr. 1965).

The isotopic composition of strontium in surface water from ten localities in the North Atlantic Ocean was determined. The results supported the conclusion that the $^{87}Sr/^{86}Sr$ ratio of the ten samples is constant within experimental errors. Eight of the ten samples came from the western half of the North Atlantic from the Bahamas to the Northumberland Straits of Nova Scotia. Two samples originated from the vicinity of the West African coast. The mean $^{87}Sr/^{86}Sr$ ratio was 0.7093 ± 0.0005 (σ), relative to $^{86}Sr/^{88}Sr = 0.1194$. This value was in agreement with determinations of most previous analysts. A model is proposed, which describes the isotopic composition of strontium in the oceans as a mixture of three isotopic varieties of strontium originating as weathering products of three types of rocks on the continents and in the ocean basins. (auth)

22542 ON THE OCCURRENCE FORM OF THORIUM ISOTOPES IN GROUND WATERS. V. S. Dementev and N. G. Syromyatnikov (Inst. of Geological Sciences, Alma-Ata, USSR). Geokhimiya, No. 2, 211-18(Feb. 1965). (In Russian)

Concentrations and occurrence forms of the thorium isotopes, ^{234}Th, ^{228}Th, ^{230}Th, and ^{232}Th were studied in some types of ground waters of Kazakhstan. The highest thorium concentrations were noted in waters containing a large amount of suspended and colloidal particles and with a high content of organic matters. With the aid of centrifugation and dialysis methods the distribution of thorium isotopes between the particles was established and found to differ by the degree of dispersion, from ionic to coarsely suspended. Differences in the behavior of isotopes with different half lives were noted and found to be apparently connected with different conditions of accumulation in natural waters. With the aid of the ion exchange method a chiefly anionic character of sorption was established. It is suggested that the transportation of thorium isotopes into ground waters is realized both in a colloidal suspension form and as anionic complexes, probably with organic acids of soils. (auth)

22543 STUDIES ON THE DETERMINATION AND DISTRIBUTION OF POTASSIUM, URANIUM, AND COBALT IN SEA WATER. R. Viswanathan, C. Sreekumaran, G. R. Doshi, and C. K. Unni (Atomic Energy Establishment, Trombay, India). J. Indian Chem., Soc., 42: 35-9(Jan. 1965).

The determination and distribution of potassium, uranium, and cobalt in sea water is discussed. An argentimetric method is recommended for the determination of potassium after precipitating the element as potassium tetraphenylboron (KTPB). An acid-base titration of the KTPB is also discussed; this method, however has a

slightly higher coefficient of variation and is more time-consuming. Surface sea water samples from the Arabian Sea were analysed for uranium. The uranium values ranged from 1.39 to 4.47 μg/l with an average of 2.56 μg/l. For exchangeable cobalt, the best possibility appeared to be to coprecipitate the element from one liter of sea water and to determine the cobalt in the precipitate on the basis of the $^{59}Co\ (n,\gamma)^{60}Co$ reaction. (auth)

22544 GAMMA SPECTRA OF THE ATMOSPHERIC FALLOUT AND AGE INDEXES AFTER THE CESSATION OF NUCLEAR TESTS. Vilem Santholzer (Charles Univ., Hradec Kralove, Czechoslovakia), Vratislav Havlovic, Pravoslav Stransky, Otakar Neruda, and Josef Knaifl. Jaderna Energie, 11: 47-51(Feb. 1965). (In Czech)

Samples of atmospheric fallout in the years 1963 and 1964, in the period after the cessation of nuclear tests, were analyzed spectrometrically. The quantities of the individual nuclides in the mixture were determined from the spectra by absolute evaluation using comparative preparations and standards. ^{54}Mn was determined along with fission products with long half lives. At the same time, ^{90}Sr was determined radiochemically. In this way it was possible to make use of several age indexes and to determine approximately the age of stratospheric fallout from their half lives. (auth)

22545 NATURAL RADIOACTIVE ELEMENTS IN THE OCEAN. Yukio Sugimura (Meteorological Research Inst., Japan). Kagaku No Ryoiki, 18: 89-101(Feb. 1964). (In Japanese).

A review is given of the distribution of natural radioactive elements and isotopes in sea waters and sediments. The U contents in sea waters are tabulated; the average is 3.3×10^{-6} g U/l. The $^{234}U/^{238}U$ ratio is discussed. The U contents in sea sediments are from 0.1 to 80 ppM. Attempts were made to determine ^{231}Pa in sea waters and sediments. Sea waters contain $2 \times 10^{-9} - 1 \times 10^{-7}$ g Th/l and $n \times 10^{-11} - n \times 10^{-14}$ g ^{230}Th/l. Sea sediments contain 6–13 ppM Th; 60–70% of the Th is leached with cold HCl. Studies were made to determine the sedimentation rate of sediment from the contents of ^{232}Th and ^{230}Th (Io). Many data are available on the ^{226}Ra contents in sea waters, and the table is given. These contents are less than those in equilibrium with U. Pelagic sediments contain an average of 10×10^{-12} g ^{226}Ra/g. Distributions of ^{210}Pb, ^{210}Po, ^{227}Ac, etc. are discussed. The surface sea waters off California contain 0.2×10^{-6} g Pb/l. The sea sediments contain an average of 30 ppM Pb. (NSA of Japan).

22546 INVESTIGATION OF THE RADIOACTIVE CONTAMINATION IN DOMESTIC AND IMPORTED FISHES. Jozsef Kovacs and Laszlo Simon. Magy. Allatorv. Lapja, 19: 424-6(Oct. 1964).

The environmental sources of radioactive contamination of foodstuffs are described with special emphasis on isotopes which are accumulated by the animal organism. The radioactive contamination present in imported salt and fresh water fish as well as domestic fish, was determined. The metallic ion fraction was used for the estimation of the degree of artificial radioactive contamination. The results indicate that there is no significant difference between the radioactive content of imported and domestic fish and their consumption is not dangerous at the present time. (CFSTI)

22547 DETECTION IN DENMARK OF THE SINKIANG NUCLEAR DETONATION. J. J. Led and L. Kristensen (Danish Defence Research Board, Copenhagen). Nature, 205: 1307-8(Mar. 27, 1965).

Evidence proving that debris from the Sinkiang explosion reached Copenhagen by transportation in the upper troposphere in less than 10 days is given. An air sampling filter exposed during the period Oct. 23-26, 1964, gave the first reliable indication of new fission products by the appearance of the 1,596 kev line of ^{140}La. Filters sampled on Oct. 28 and Oct. 30 showed concentrations that were approximately 10 and 100 times greater. Later measurements on a rain sample from Oct. 23 finally proved that the transportation time did not exceed 7 days. (P.C.H.)

22548 STUDYING RADIOISOTOPE MIGRATION IN SOILS. DISTRIBUTION OF STRONTIUM^{90}. E. B. Tyuryukanova, F. I. Pavlotskaya, A. N. Tyuryukanov, and V. I. Baranov. Pochvovedenie, No. 8, 88-95(1964). (In Russian)

^{90}Sr from the atmosphere was found to accumulate on poorly drained unmown bottomlands and in water-logged depressions adjacent to sandy watersheds. The vertical distribution of ^{90}Sr in a given geochemical landscape was found to depend on the genetic soil type and the character and thickness of its humose horizon. (auth)

22549 MIGRATION AND DISTRIBUTION OF STRONTIUM-90 AND CERIUM-144 IN SOILS OF MOSCOW REGION. E. B. Tyuryukanova, F. I. Pavlotskaya, A. N. Tyuryukanov, L. N. Zatsepina, E. V. Babichev, and L. M. Rodionova. Pochvovedenie, 10: 66-73(1964). (In Russian)

Distribution of radioisotopes in genetic horizons of the soils of Moscow region was studied. It was found that ^{90}Sr and ^{144}Ce are distributed in soil profiles according to not only the soil type but also vegetation, geomorphology, and other conditions. (auth)

22550 RADIOACTIVITY IN THE AIR. I. Escobar (Universidad Mayor de San Andres, La Paz, Bolivia). Publ. Lab. Fis. Cosmica, Univ. Mayor San Andres, No. 26, 71-6(Nov. 1964). (In Spanish)

The principal natural and artificial radioisotopes in the air are summarized. The procedures used for measurement and sampling are briefly described. The equipment necessary for the measurements is tabulated. (J.S.R.)

22551 SUMMARY OF RESULTS FROM THE RAW MILK SAMPLING PROGRAM. Jeptha E. Campbell and Gopala K. Murthy (Robert A. Taft Sanitary Engineering Center, Cincinnati). Radiol. Health Data, 4: 511-23(Oct. 1963).

This report summarizes the data on radionuclides in raw milk obtained at monthly intervals, since early 1957, from selected groups of dairy farms in different areas of the U.S.A. During the first year of operation of the raw milk network, five areas were selected for surveillance: New York, Cincinnati, St. Louis, Salt Lake City, and Sacramento. In the second year stations were added at Atlanta, Chicago, Fargo-Moorhead, Austin, and Spokane. Regular monthly samples have been received from all stations, and analyzed for Ca and K content, ^{131}I, ^{140}Ba, ^{137}Cs, ^{89}Sr, and ^{90}Sr. These milk samples represented one or two days of production rather than a composite of all the milk produced from one sampling period to the next. This sampling procedure has proved satisfactory for ^{90}Sr and ^{137}Cs and unsatisfactory for ^{131}I, ^{140}Ba, and ^{89}Sr. Analysis of single monthly samples and composites of daily milks showed no significant differences for ^{90}Sr and ^{137}Cs. Extension of this study in the Cincinnati area to a period of relatively rapid change (April to September 1962) of ^{90}Sr in milk showed also that results between composited and single monthly samples are comparable within 25 to 50%. However, during periods of rapid change in ^{90}Sr, the time of collection of single monthly samples becomes important. Samples collected either at the beginning or end of the month may vary in ^{90}Sr concentration by as much as 25 to 75%. In contrast to ^{90}Sr and ^{137}Cs, single monthly observations made for ^{131}I, ^{140}Ba and ^{89}Sr do not represent the actual level during the intervening period, and it is suggested that daily sampling is needed to obtain accurate estimates. The ^{90}Sr concentrations of milk samples from the raw milk and pasteurized milk networks serving the nine cities were compared over a period of 26 months. Good correlation was found between the raw and pasteurized milks except for those from Sacramento, possibly due to low ^{90}Sr levels in the Sacramento area, which showed relatively little change with time, and errors involved in determining low levels of ^{90}Sr. It is suggested that except for St. Louis and Atlanta, the ^{90}Sr results from the raw milk network may be used in place of pasteurized milk for the time period not covered by the pasteurized milk network. Charts for the yearly average ^{90}Sr and ^{137}Cs concentrations in raw milk show the similarity among the widely separated geographical areas in the trend of concentrations of these fission products in milk. Strontium-89, which was present in milk during 1957-59, decreased

to nondetectable levels for the network in 1960. Through 1962, concentrations rose at some locations to about the previously observed values of 1957-59, but the median values were lower levels in 1961-62 than in the late fifties. The appearance of the long-lived isotopes ^{90}Sr and ^{137}Cs in milk follows a very different pattern from the short-lived radionuclides. Rapid fluctuation of concentrations of radionuclides with a long half-life does not occur. Strontium-90 levels in milk rose, beginning in 1957, reaching a peak in 1959. Cesium-137 concentrations for the network generally did not change during these years. Both ^{90}Sr and ^{137}Cs showed decreasing trends during 1960-61. However, in 1962 ^{137}Cs concentrations in milk rose again to the levels present in the late fifties, while ^{90}Sr concentrations in milk had risen in 1962 to levels exceeding those recorded in the previous high year, 1959. (BBB)

22552 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME V, NUMBER 12. (Public Health Service, Washington, D. C.). Dec. 1964. 52p. $0.50(GPO).

Data are presented on the gross β activity in samples of surface air and precipitation collected throughout the North American continent during Aug. 1964; the content of ^{137}Cs, ^{89}Sr, and ^{90}Sr in samples of pasteurized milk from the U. S. and Canada collected during Aug. 1964; the content of ^{90}Sr in the average diet of individuals living in New York City, San Francisco, and Chicago during Feb., March, and April, 1964; and the gross α and β radioactivity and ^{90}Sr content in surface waters sampled during June 1964. Data are included on the content of ^{40}K, $^{95}Zr-^{95}Nb$, ^{106}Ru, ^{137}Cs, ^{89}Sr, and ^{90}Sr in samples of caribou and reindeer muscle, rumen contents, and bone from caribou (Rangifer caribou) and reindeer (Rangifer tarandus) of herds from various locations in Alaska sampled during 1964. Summaries of the environmental radioactivity at Brookhaven National Laboratory and the Dow Chemical Company Rocky Flats Plant (Colo.) from July 1963 to July 1964 are presented. During Nov. 1964 one underground nuclear experiment was announced by the AEC. A separate abstract was prepared for one section of this report. (C.H.)

For an abstract of the individual section see: 21848.

22553 CESIUM-137 IN MILK FROM DRY-LOT AND PASTURE-FED COWS IN FORT COLLINS, COLORADO, DURING 1963. James E. Johnson and Gerald M. Ward. Radiol. Health Data, 6: No. 1, 29-30(Jan. 1965).

Milk from dry-lot and pasture-fed cows was analyzed for ^{137}Cs content. The data show that milk ^{137}Cs content responded rapidly to changes in the activity of the cows' feed and that the activity of pasture forage reached a maximum coincident with heavy spring rains and declined thereafter. The data illustrate the effects of farm feeding practices on the ^{137}Cs content of milk. (C.H.)

22554 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME 6, NUMBER 1. (Public Health Service, Washington, D. C.). Jan. 1965. 77p. $0.50(GPO).

Data are presented on gross β activity due to fallout in samples of air and precipitation collected throughout North America during Sept. 1964; fission product γ activity in samples of surface air collected along the 80th meridian during May and June 1964; the content of ^{137}Cs and ^{90}Sr in samples of milk collected in the U. S. and Canada in Sept. 1964; the ^{89}Sr, ^{90}Sr, and ^{226}Ra content in diet samples from 41 representative U. S. institutions during the second quarter of 1964; the radioactivity of surface waters of the U. S. during July 1964; the radioactivity in Florida surface and ground waters during 1962 and 1963; and the radioactivity in Minnesota surface water supplies during the first half of 1964. Summaries are included on environmental radioactivity at Hanford, Wash. and Oak Ridge, Tenn. during 1963. Four underground nuclear tests were announced by the AEC during Dec. 1964. Separate abstracts were prepared for three sections of this report. (C.H.)

For abstracts of individual sections see: 22553, 22555, and 22556.

22555 RADIONUCLIDE LEVELS IN TEEN-AGE DIETS— A COMPARATIVE STUDY OF TWO SAMPLING PROGRAMS, FEBRUARY–JUNE 1964. Edmond J. Baratta and Edward R. Williams. Radiol. Health Data, 6: No. 1, 37-40(Jan. 1965).

The content of ^{90}Sr, ^{137}Cs, stable Ca, and stable K in the diets of teenagers in 10 representative U. S. cities was determined from Feb. to June 1964. The contribution of milk to the total radionuclide intake was evaluated by the collection of duplicate samples. The daily food consumption ranged from 2.77 to 4.76 kg and stable Ca intakes ranged from 1.6 to 3.0 g/day. Intake values for ^{90}Sr ranged from 19 pC/day in Los Angeles to 101 pC/day in Bismarck, North Dakota and intake values for ^{137}Cs ranged from 160 pC/day in Los Angeles to 720 pC/day in Portland, Oregon. Good agreement was found between values for samples obtained by two separate sampling programs. (C.H.)

22556 MICHIGAN DEPARTMENT OF HEALTH REACTOR ENVIRONMENTAL SURVEILLANCE PROGRAM— A SUMMARY REPORT. G. A. Jacobson, D. E. Van Farowe, J. M. Hennigan, and R. C. Bennett. Radiol. Health Data 6: No. 1, 49-60(Jan. 1965).

The Big Rock Point power reactor, located on Lake Michigan about 5 mi from Charlevoix, became operational in 1962 and the Enrico Fermi power reactor, located on Lake Erie about 30 miles from Detroit, became operational in 1963. The reactor environmental monitoring program of the Michigan Department of Health in the reactor areas is described. Typical data are presented. (C.H.)

22557 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME 6, NUMBER 2. (Public Health Service, Washington, D. C.). Feb. 1965. 44p. $0.50(GPO).

Data are presented on the fission product β activity in samples of airborne particulates and precipitation collected throughout North America during Oct. 1964; the content of ^{137}Cs, ^{131}I, ^{89}Sr, and ^{90}Sr in samples of milk collected in the U. S. and Canada in Oct. 1964; and the gross α and β activity in samples of surface water collected in the U. S. during Aug. 1964. Data are included on environmental levels of radioactivity at the Union Carbide Nuclear Company, Paducah, Ky., the General Electric Pinellas Peninsula Plant, Fla., and the Savannah River Plant, S. C., from Jan. to July, 1964. During Jan. 1965 the AEC announced 2 underground nuclear tests and one Soviet test conducted Jan. 15 was identified as being in the intermediate yield range. (C.H.)

22558 A REVIEW OF MEASUREMENTS OF RADIOACTIVITY IN FOOD, ESPECIALLY DAIRY MILK, AND A PRESENTATION OF THE 1963 DATA ON Cs^{137} AND Sr^{90}. B. Lindell. Stockholm, Radiation Protection Board, Inst. of Radiophysics, 1964. 46p.

Cesium-137 has been estimated in dried milk from 2 factories in Sweden since 1958 and in samples of milk taken at about fortnightly intervals from 15 dairies in 1962 and 32 dairies in 1963. The weighted averages for 1962 and 1963 were respectively 75 and 185 pc ^{137}Cs/l milk; a maximum country-wide average of 385 pc was obtained for August 1963. Some estimations of ^{90}Sr have been made and the average was about 20 pc ^{90}Sr/g Ca for the 1st half of 1963 and about 40 pc ^{90}Sr/g Ca for the 2nd half of 1963. Public Health Eng. Abstr., 45: (Feb.-Mar. 1965).

22559 FALLOUT FROM THE NUCLEAR EXPLOSION OF 16 OCTOBER 1964. D. G. Rea (Univ. of California, Berkeley), B. T. O'Leary, and W. M. Sinton. Science, 147: 1284-8(Mar. 12, 1965).

Measurements of the concentrations of 20 fission products in a sample of rain collected at Fayetteville, Arkansas, on 26 October 1964, yielded two "mass-yield" curves; one for fresh debris from the Chinese nuclear explosion, and another for older debris. The former curve resembled the mass-yield curve for neutron-induced fission of uranium-235. (auth)

22560 STRATOSPHERIC TAPPING BY INTENSE CONVECTIVE STORMS: IMPLICATION FOR PUBLIC HEALTH

IN THE UNITED STATES. A. Nelson Dingle (Univ. of Michigan, Ann Arbor). Science, 148: 227-9(Apr. 9, 1965).

The observation of a cloud-free vortex in the top of a violent convective storm over Oklahoma suggests a mechanism whereby large quantities of air may be brought directly from the lower stratosphere to the lower troposphere in the central part of such storms. That this mechanism, in combination with the torrential rains frequently generated by these systems, is capable of producing radioactive hot spots on the ground is pointed out. Climatological considerations and observations of accumulated strontium-90 in soils support the hypothesis that the Plains States are peculiarly subject to heavy contamination compared to other middle-latitude areas because of this mechanism. (auth)

22561 THE RELATIONSHIP BETWEEN PRECIPITATION AND RADIOACTIVE FALLOUT. PART I. Kazuyoshi Ito and Masatoshi Idogaki (Shimane Univ., Japan). Shimane Daigaku Ronsho, Shizen Kagaku, No. 14, 1-7(Dec. 1964). (In Japanese)

The analysis of fallout data showed that radioactivity of the total fallout is approximately proportional to the amount of rainfall, yet the activity per unit volume of precipitation decreases with increasing rainfall. This fact suggests that we must consider the contribution of dry deposition. Analysis of gamma-ray spectrum indicated six photopeaks. It is estimated that these peaks are due to $^{144}Ce-^{144}Pr$, ^{103}Ru, $^{106}Ru-^{106}Rh$, $^{95}Zr-^{95}Nb$, and ^{40}K. The result of total beta-ray measurements was almost the same as that of gamma-rays. (auth)

22562 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME 6, NUMBER 3. (Public Health Service, Washington, D. C.). Mar. 1965. 54p. $0.50(GPO).

Data are presented on fission product β activity in samples of airborne particulates and precipitation collected throughout North America during Nov. 1964; the content of ^{90}Sr in fallout samples collected in the U. S. and other areas from April through June, 1964; the content of ^{137}Cs and ^{90}Sr in samples of pasteurized milk collected during 1964; the ^{90}Sr content of the average diet of individuals living in Chicago, New York City, and San Francisco from May through June, 1964; the estimated daily intake of radionuclides in California diet from Jan. through June, 1964; the gross radioactivity and ^{90}Sr content in surface waters of the U. S. during Sept. 1964; and results of a survey of Ra sources in Kentucky during Dec. 1963 and Jan. 1964. Data are included on environmental levels of radioactivity at Argonne National Laboratory; Atomics International, Canoga Park, Calif.; and the National Reactor Testing Station, Idaho Falls, Idaho, from Jan. through June 1964. During the month of Feb. 1965, 3 underground nuclear tests at the Nevada Test Site were announced by the AEC. (C.H.)

22563 AN EVALUATION OF ABSOLUTE AGES FOR THE ELEVATED MARINE TERRACES OF THE PALOS VERDES HILLS AREA BASED ON URANIUM SERIES INEQUILIBRIUM IN MOLLUSKS. David L. Thurber and Wallace S. Broecker. 32p. (CONF-498-7)

From Geological Society of America 1963 Annual Meeting, New York, Nov. 1963.

An attempt was made to determine the absolute ages of the elevated marine Pleistocene deposits in the Palos Verdes Hills area of California. To this end measurements of ^{238}U, ^{234}U, ^{230}Th, ^{226}Ra, and ^{232}Th were made in 40 samples of marine mollusks from these deposits. Ages computed from the $^{230}Th/^{234}U$ ratio in these shells were evaluated on the basis of known stratigraphic relationships, mineralogy, and internal agreement of the isotope data itself. Whereas calcitic forms were too high in common thorium for reliable dating, the aragonitic forms generally yielded internally consistent results. Tentative absolute ages of 130,000 years for the Palos Verdes sand, 185,000 years for the Lomita marl, and of more than 250,000 years for the fifth and higher terraces are assigned. Helium accumulation ages by Fanale and Schaeffer agreed with these values. However, the unexpectedly high $^{234}U/^{238}U$ ratios pointed to a secondary origin for the uranium. Although available evidence suggests that the addition took place early in the diagenetic history, the ages given may prove to be too low. (auth)

22564 OXYGEN-18, DEUTERIUM AND TRITIUM IN NATURAL WATERS AND THEIR RELATION TO THE GLOBAL CIRCULATION OF WATER. Erik Eriksson and Bert Bolin (International Meteorological Inst., Stockholm). 14p. (CONF-765-10)

From 2nd Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 1964.

The occurrence of deuterium, tritium, and ^{18}O in natural waters is discussed on the basis of the general circulation of water derived from standard meteorological observations of humidity, precipitation, and evaporation. If the establishment of a characteristic vertical distribution of moisture, deuterium, and ^{18}O is rapid (a few days) in comparison with the large scale horizontal transfer rates of moisture over the oceans, the vertical distribution of deuterium and ^{18}O in air moisture and the content of these isotopes in precipitation can be related to the humidity distribution, the isotopic composition of sea water, and the characteristic fractionation factor for condensation-evaporation. Observed isotopic composition of rain water and measurements of tritium in atmospheric moisture over equatorial regions are discussed in view of these theoretical results. Furthermore, the meridional transports of moisture, deuterium, and ^{18}O, with the ocean surface considered the source for these isotopes, were compared with the transfer of tritium from a stratospheric source. An estimate was made of the total inventory of tritium and related to the global fallout of tritium. (auth)

Site Survey and Selection

22565 SITE SELECTION FOR NUCLEAR POWER PLANTS. Martin Ellmer. At. Strom, 11: 1-8(Jan. 1965). (In German)

The factors that must be considered in the selection of a site for nuclear power plants are discussed. They are the energy economy, land for construction, water availability, meteorology, publicity, and transport of the heavy plant elements. (J.S.R.)

22566 SITE SELECTION FOR NUCLEAR POWER PLANTS (GEOLOGY, METEOROLOGY, PROXIMITY OF CONSUMPTION CENTERS, AND PUBLIC OPINION). M. Ellmer (Rheinisch-Westfalischen Elektrizitatswerk AG, Essen, Ger.). Neue Tech., 7: 1-7(Feb. 1965). (In German).

Factors in choosing a site for a nuclear power plant, which must be evaluated in such a way that the most economic solution can be found, are discussed. Factors considered are: power economics for basic choice of site area and size of power plant; geology, including earthquakes for questions concerning the foundations and basic conception of the power plant, and for the principles of construction; hydrology (ground and surface water) also for the basic conception of the power plant and lay-out size; meteorology for lay-out with reference to safety from radioactivity in the surrounding area; public work; and transport of heavy pieces. (auth)

Techniques and Equipment

22567 (NYO-1669-10) INVESTIGATIONS IN ISOTOPIC GEOCHEMISTRY. Annual Progress Report No. 10. J. Laurence Kulp (Lamont Geological Observatory, Columbia Univ., Palisades, N. Y.). Jan. 1965. Contract AT(30-1)-1669. 201p. Dep.(mn); $6.00(cy), 4mn) CFSTI.

A study of basalt system K–Ar dating was completed in which technique advances were made. The method was applied in age determinations of surficial rocks. Work on superimposition of metamorphic and thermal events on rocks from the Manhattan prong and southwestern Connecti-

cut was continued. U–Pb isotopic ages on about 20 zircons from the Norwegian and Swedish basement were completed. Determinations of the K–Ar ages of laramide intrusions in the Rocky Mountain area were also completed. Age measurements on samples from the areas around Fairbanks and Juneau, Alaska are discussed. (J.R.D.)

22568 (VESIAC-4410-77-X) REPORT OF VESIAC WASHINGTON CONFERENCE PROCEEDINGS: A REVIEW OF BROADBAND SEISMOGRAPHS TO INCLUDE DIGITAL SEISMOGRAPHS. (Michigan Univ., Ann Arbor. Acoustics and Seismics Lab.). Oct. 1964. Contract SD-78. 123p.

Papers presented at a VESIAC (Vela Seismic Information Analysis Center) Special Study Conference, held 18 and 19 November 1963, on recent developments in wideband seismic recording are collected. Emphasis is placed on advances in digital recording and problems related to digital recording systems. A related report is included on a pressure-sensitive transducer, known as the "Solion Transducer," applicable to hydroacoustic sensing. (auth)

22569 (VESIAC-8859VU) SEISMIC ARRAYS FOR THE DETECTION OF NUCLEAR EXPLOSIONS. Scientific Report No. 8. Enders A. Robinson (Massachusetts Inst. of Tech., Cambridge). May 1964. Project VELA-UNIFORM. Contract AF19(604)-7378. 108p. (AFCRL-64-855)

Seismic arrays are multichannel sensor patterns immersed in a multi-dimensional signal-noise field and the analytic problem is hence analogous to that of radar antennas. The subject is thus opened first by a review of antenna theory, considering questions of aperture width, antenna resolution, and of optimum design criteria, and secondly by a review of spectral theory, including special examination of the Ross "time gates." The general optimization problem for multichannel data leads to large systems of normal equations of Toeplitz form (as presented in previous reports) which require recursion solution techniques to be computationally feasible. Such techniques are elaborated in terms of polynomials orthogonal on the unit circle. The specific seismic array problem is then considered in terms of plane-wave-front signal and noise contributions plus incoherent noise, and details of the "velocity filtering" method are presented. All practical array filtering rests ultimately on empirical measurements of signal and noise properties, especially of spectral behavior. Spectral estimation from finite array measurements is the final question considered, including relations between continuous and discrete aperture functions, and the tabulation of aperture functions with their windows. (auth)

22570 LABORATORY INVESTIGATIONS ON THE DETERMINATION OF FILTRATION VELOCITY BY MEANS OF RADIOISOTOPES. M. Borowczyk (Geological Inst., Warsaw), J. Mairhofer, and A. Zuber. Atomkernenergie, 10: 51-6(Jan.-Feb. 1965).

Model measurements have been performed for two different types of soils and various piezometer perforations. They show that if the perforation is suitably high (8 to 10%) the operation conditions of an "ideal" piezometer are obtained. An exception seems to occur for filtration velocities of the order of 5×10^{-2} cm/sec and more, where the "ideal" state is reached only about 30% perforation. Special attention was paid to specific problems occurring at high filtration velocity measurements, since up till now there were no publications concerning this topic. The dependence of the change of the tracer dilution on the filtration velocity, given graphically, allows proper planning of measurements. Since for very high filtration velocities the time in which the isotope is removed from the bore-hole is very short, it is practical and sometimes even necessary to use rate-meters. Thus, diagrams facilitating proper choice of the time constant of the rate-meter are also included. (auth)

22571 THE INFLUENCE OF MEASURING PROBES ON THE EXAMINATION OF THE FILTRATION RATE OF UNDERGROUND WATERS IN BORE HOLES AND PIEZOMETERS. Czeslaw Krolikowski (Geological Inst., Warsaw). Atomkernenergie, 10: 57-61(Jan.-Feb. 1965).

The electrical and isotopic methods of determining flow direction and filtration velocity of underground water are discussed. Since the presence of a measuring probe in the bore hole can change considerably the filtration rate value, a rate formula allowing for the influence of measuring probe was given. The analytical form of a coefficient was derived, permitting computation of the filtration rate in a noncohesive medium, if the flow rate in the bore hole has been measured. To determine this coefficient the problem of potential flow on plane with allowance for disturbing influence of measuring probe, bore hole and filter was solved. Then some particular cases were analyzed. The coincidence of these equations with the formerly derived formulas was stated. The system of curves for desired values of parameters was plotted. (auth)

22572 THE POSSIBILITY OF USING PHOTONUCLEAR REACTIONS TO DISTINGUISH AN OIL-WATER CONTACT. N. P. Mazyukevich, A. M. Parlag, and V. A. Shkoda-Ul'yanov. Dokl. i Soobshch. Uzhgorodsk. Gos. Univ., Ser. Fiz. Mat. Nauk, No. 4, 3-6(1961).

The use of photoneutron emission from water in oil prospecting was evaluated on the basis of the theoretical emission of a beam of photons for the energy range 2.25-15 Mev. It was found that the emission of photoneutrons from the oil and water differs only negligibly in the region 2.25-5 Mev. However, if the higher deuterium content in the hydrogen of the oil in comparison with the water is taken into account, then the difference in emissions becomes sufficiently large to distinguish between the oil and the water. Since the difference is still small, and since the threshold for the formation of photoneutrons from ^{13}C is ~5 Mev, the most convenient range of photon energies for petroleum prospecting seems to be 7 Mev. (CFSTI)

22573 INVESTIGATIONS ON THE POROSITY IN WELLS BY MEANS OF LOGGING APPARATUSES USING RADIOACTIVITY. PART II. Toshiro Ochiai (National Inst. of Agricultural Sciences, Japan). Genshiryoku Kogyo, 10: No. 10, 49-56(Oct. 1964). (In Japanese)

Applications of logging apparatuses using radioactivity to investigate porosity in the seam for the quantitative evaluation of water resources are described. The principles and uses of both γ-γ and n-γ logging apparatuses are illustrated. Underground water in the base rock is in the irregular crevices and flows. Therefore, the γ-γ logging apparatus can be used to determine the amount of water for deep wells. The n-γ logging apparatus is suitable for seams of smaller porosities. The responses from the n-γ logging apparatus revealed the sum of crystallographic structural water and gravity water in rocks. (NSA of Japan)

22574 THE INVESTIGATION OF THE GEOGRAPHICAL AND VERTICAL DISTRIBUTION OF SEVERAL TRACE ELEMENTS IN SEA WATER USING NEUTRON ACTIVATION ANALYSIS. Donald F. Schutz and Karl K. Turekian (Yale Univ., New Haven). Geochim. Cosmochim. Acta, 29: 259-313(Apr. 1965).

Methods for the determination of 18 trace elements in sea water by neutron activation analysis were developed. Of these elements sufficient analyses were completed for gold, selenium, antimony, silver, cobalt, and nickel to permit a discussion of their distributions in the world ocean. The distributions of gold, selenium, and antimony were more uniform than those of silver, cobalt, and nickel, so little could be concluded regarding the processes important to their supply to and removal from the world ocean. The variations observed for silver, cobalt, and nickel, however, made possible the evaluation of several factors that influence their concentrations in the ocean. The Atlantic Ocean north of 10°S receives 60% of the total dissolved material supplied to the ocean by streams, but is lower in silver, cobalt, and nickel than is the remainder of the world ocean indicating that continental run-off is not important in the deep-sea economy of these elements. Relatively high concentrations of cobalt and nickel were found in water of the central Pacific Ocean in areas where the cobalt/manganese and nickel/manganese ratios in manganese nodules are high. The evidence that the nodule material in these areas is of volcanic origin may also imply a volcanic origin for the cobalt and nickel in the overlying

water. No such source was indicated for silver. Unweathered rock material supplied directly to the ocean by Antarctic glaciers seemed to be sufficient to affect the silica economy of the ocean and may in part affect the economy of other trace elements such as cobalt and nickel. The data were not sufficient, however, to permit an unambiguous interpretation. Cobalt and nickel were relatively low in Long Island Sound compared to the North Atlantic indicating near-shore removal of these elements from sea water. In the deep sea much of the cobalt and nickel may be removed by co-precipitation with manganese oxide, but no mechanism seemed singularly important in the removal of silver. Increase in concentration of silver, cobalt, and nickel with depth in areas of high organic productivity indicated alteration of trace element concentration by organic reactions. In areas where upwelling currents oppose the downward movement of organic material a relatively high steady state concentration may be produced. (auth)

22575 PROJECT SHOAL VOLUNTEER TEAM PROGRAM. R. A. Weisbrich (Geotechnical Corp., Garland, Tex.). Geophysics, 30: 262-78(Apr. 1965).

SHOAL, the second underground nuclear test announced sufficiently well in advance to permit Volunteer Team Program participation, was detonated in Western Nevada on October 26, 1963. Twenty-four volunteer teams from exploration seismograph crews, universities, research organizations, and independent observers joined in monitoring this event. Sixteen teams recorded energy from the explosion. Results obtained by these teams are summarized and reproductions of some of the seismograph records are included. (auth)

22576 DETERMINATION OF THE POROSITY OF GROUND-WATER AQUIFERS BY THE RADIOACTIVE TRACER TECHNIQUE. I. B. Hazzaa, K. F. Saad, R. K. Girgis, A. A. Bakr, and F. M. Swailem (Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo). Intern. J. Appl. Radiation Isotopes, 16: 261-5 (Apr. 1965).

The radioactive tracer technique was used for the determination of the effective porosity of a ground water-bearing formation. Radioactive iodine ^{131}I, was found to be a suitable tracer. A device for injecting the isotope at desired depths in a piezometer, tapping the aquifer, was made. The time of arrival of the tracer injected in the piezometer to a neighboring pumped well was registered. From the value of the constant pumping rate, the distance between the piezometer and the pumped well, and the thickness of the aquifer, the effective porosity could be calculated. An average value of 0.20 ± 0.01 for the effective porosity was obtained. This is in good agreement with the value 0.26 obtained earlier by the electrical resistivity method at the same site. (auth)

22577 CARBON ISOTOPE COMPOSITION OF INDIVIDUAL HYDROCARBONS FROM ITALIAN NATURAL GASES. U. Colombo (G. Donegani Research Inst., Novara, Italy), F. Gazzarrini, G. Sironi, R. Gonfiantini, and E. Tongiorgi. Nature, 205: 1303-4(Mar. 27, 1965).

An experimental technique, based essentially on gas chromatography, which enables the quantitative separation of individual carbon compounds from natural gases, is described. Each hydrocarbon is converted to CO_2, which is then analyzed for the $^{13}C/^{12}C$ ratio using a mass spectrometer. Reproducible results are thus obtained, with an overall accuracy of ±0.3 per mil. This technique was applied to the examination of natural gases from nine producing fields, located in southern Italy and Sicily. The chemical composition of such gases was also determined by gas chromatography. It was found that the ^{13}C content of methane decreases with increasing molar ratio (methane/tptal hydrocarbons) in the gases. The results suggest that isotopic fractionation during migration of the gas from the source to the trap positions might be so important as to become the dominant feature of the over-all isotopic fractionation measured. (P.C.H.)

22578 PRECURSOR SHOCKS PRODUCED BY A LARGE-YIELD CHEMICAL EXPLOSION. John M. Dewey (Suffield Experimental Station, Ralston, Alberta). Nature, 205: 1306(Mar. 27, 1965).

In July 1964, a 500 ton TNT hemispherical surface burst charge was detonated at Suffield Experimental Station in Alberta, Canada. High-speed photographs of the explosion showed that in some radial directions dust clouds moved out ahead of the main shock and had reached a height of 50 ft before its arrival. The dust clouds were enveloped by a shock wave. At ground-level this precursor eventually became downward facing and produced a reflected shock and a Mach stem. The precursors occurred in the region 250-750 ft from the center of the explosion, corresponding to peak overpressure levels of 150 lb/in^2. It seems probable that the precursors were produced by strong ground waves feeding energy into the air ahead of the air shock. (P.C.H.)

22579 FISSION-TRACK DATING OF BED I, OLDUVAI GORGE. R. L. Fleischer (General Electric Research Lab., Schenectady, N. Y.), P. B. Price, R. M. Walker, and L. S. B. Leakey. Science, 148: 72-4(Apr. 2, 1965).

The discoveries of a series of hominid remains in the Olduvai Gorge, Tanganyika, has focused attention upon the age of the deposits of Bed I, in which both Zinjanthropus and Homo habilis were found. Because the age of 1.75 million years, as determined by the radioactive decay of potassium and argon, has been questioned several times, a fission-track age was measured for the pumice from Bed I. The result is 2.03 ± 0.28 million years, in good agreement with the result obtained by the potassium–argon decay method. (auth)

22580 RADIOCARBON DETERMINATION FOR ESTIMATING GROUNDWATER FLOW VELOCITIES IN CENTRAL FLORIDA. Bruce B. Hanshaw, William Back, and Meyer Rubin (Geological Survey, Washington, D. C.). Science, 148: 494-5(Apr. 23, 1965).

Carbon-14 activity was determined from HCO_3^- in samples of groundwater obtained from the principal artesian aquifer in Florida. From these data the age of water obtained from a series of wells, each progressively farther down gradient on the piezometric surface, was established. Relative carbon-14 ages indicated a velocity of groundwater movement of 23 feet (7 meters) per year for about 85 miles (137 kilometers) of travel. A velocity of 23 feet per year was calculated independently from Darcy's law. (auth)

22581 GROUNDWATER TRACING BY TRITIATED WATER INJECTION. George J. Kriz, David C. Lewis, and Robert H. Burgy (Univ. of California, Davis). St. Joseph, Mich., American Society of Agricultural Engineers, 1965, Preprint Paper No. 64-821, 12p. (CONF-641207-4)

From American Society of Agricultural Engineers, Winter Meeting, New Orleans.

The properties of tritiated water, THO, and its applicability to groundwater tracing are discussed. Some specifically designed tracer experiments are described for determining direction of flow, source location, average flow velocity through the pores, apparent flow velocity through porous medium, and effective porosity of the medium. (M.C.G.)

Thorium and Uranium Minerals

22582 THE PRESENT STATE OF URANIUM MINES AND THE RADIATION CONTROL. Hidekatsu Misawa and Iori Koga (Japan Atomic Fuel Corp., Tokyo). Genshiryoku Kogyo, 10: No. 4, 18-23(Apr. 1964). (In Japanese)

The uranium mines in Japan and radiation control in them are described. Uranium mines in Japan are developed by the Atomic Fuel Corporation. Only two mines at the Ningyo-toge and Nakatsugawa areas have been worked on a large scale. A method using a jet of high pressure water is under investigation. Although the ores being produced are poor in uranium concentration, compared with others in other countries, effective dressing may be carried out by mere washing. An experimental refinery is

under construction where concentrated ores are leached and the mill solution is separated. The solution is extracted, converted, and counter-leached; then electrolysis followed by fluoridation is carried out. The final product is UF_6. The substances involved in radiation control in mines are radon and its disintegration products, radioactive dusts, radiations from the ores, exhaust radioactive gases, used water, etc. (NSA of Japan)

22583 RADIATION CONTROL. Shigenobu Ono (Japan Atomic Fuel Corp., Tokyo). Genshiryoku Kogyo, 10: No. 4, 24-8(Apr. 1964). (In Japanese)

Descriptions are given of the radiation control at the mines of the Japan Atomic Fuel Corporation. In these uranium mines, U-series, Ac-series, and Th-series are the main substances for radiation control; among them, the α rays from Rn^{222} of the U-series are most important. At present, ionization chambers are used for Rn^{222}. The daughters of Rn are measured by mathematically analyzing the decrease in the α-ray intensity. In the measurement of mine dusts, the amount of U_3O_8 in the dust is measured chemically, using Takara or Stanplex Co.'s samplers. The atmospheric radioactivities are measured by the same method. In the measurement of exhaust gases, a continuous counter called a dust monitor is used. For dose measurements, γ-ray survey meters (GM-102 type) are usually used. In the measurement of surface contamination, the smear method is used. In the measurement of radioactivity in water, the sample is first evaporated and concentrated and the activity is measured with a sample changer. In personnel radiation control, film badges are used. There are still many problems left to be solved in the radiation control of the mining areas. (NSA of Japan)

22584 TRACKS OF FISSION FRAGMENTS OF URANIUM IN MUSCOVITE. Yu. A. Shukolyukov, I. N. Krylov, I. N. Tolstikhin, and G. V. Ovchinnikova (Lab. of Geology of the Precambrian, Leningrad). Geokhimiya, No. 3, 291-301(Mar. 1965). (In Russian)

Fission fragments of ^{238}U nuclei in muscovite from the Mamsk region with an age of 363 million years, according to the K/Ar-method, formed tracks visible under an optical microscope with a magnification of 500× after a treatment in 20% HF for 20 hours. The tracks were prisms with a base in the form of a rhomb, with an axis ratio of ~1.4. The axes of all rhombic bases were equally oriented. Four cases of a third fragment emission in uranium fission were found. The track distribution on an area of 100 cm^2 obeyed the law of normal distribution. The activation energy of track annealing was found by the tempering method to be 22000 ± 5000 cal/mol. It ensures track preservation during geological time only under conditions that the sample temperature never exceeded 200°C. The uranium concentration corresponding to the observed number of tracks was $\approx 10^{-9}$ g/g of muscovite, with the uranium distributed in mica as single atoms or groups with not more than 10^3 atoms in each group. (auth)

22585 URANIUM AND ORGANIC MATTER IN SEDIMENTS OF THE BLACK SEA AND THE MEDITERRANEAN. A. V. Kochenov, G. N. Baturin, S. A. Kovaleva, E. M. Emelyanov, and K. M. Shimkus. Geokhimiya, No. 3, 302-13(Mar. 1965). (In Russian)

Schemes of organic carbon and uranium distribution in sediments of the Black Sea and the Mediterranean Sea are given. From sediments of the Black Sea a direct correlation between the content of organic matter and uranium was established. Their maximum contents gravitated toward the tehalistatic zones of the Black Sea. The cause of an intensified accumulation of organic matter with bound uranium are the anaerobic conditions in this reservoir. (auth)

22586 URANIUM IN CANADA. Ottawa, Eldorado Mining and Refining Ltd., 1964. 146p.

The story of uranium and the manner in which it became important to mankind is related. A generalized account is given of the uranium mining industry of Canada and the method by which uranium is produced. The chemical leaching process for removal of uranium from ores is described. (M.C.G.)

22587 BEARING OF STABLE ISOTOPIC GEOLOGY ON THE ORIGIN OF THE GAS HILLS, WYOMING, URANIUM DISTRICT. E. S. Cheney and M. L. Jensen (Yale Univ., New Haven). New York, Society of Mining Engineers, 1964, Preprint No. 64L19, 37p. (CONF-524-16)

From American Institute of Mining, Metallurgical and Petroleum Engineers Annual Meeting, New York, Feb. 1964.

The sandstone-type uranium deposits of the Gas Hills occur in the arkosic, lower Eocene Wind River formation on the southern edge of the Wind River Basin. The ^{34}S values of pyrite cement associated with uranium mineralization were significantly lighter than values for syngenetic-diagenetic pyrite nodules, therefore the H_2S responsible for the precipitation of the epigenetic pyrite and uraninite was produced epigenetically. These values were much lighter than the values of H_2S from neighboring oil fields. The presence of biogenic pyrite in meta-igneous Precambrian cobbles indicated that these cobbles are not remnants of former vein-type uranium deposits. The isotopic composition of ground water sulfate from the younger tuffaceous sediments was compatible with the hypothesis that the anaerobic bacteria reduced this sulfate. The extremely light values for pyrite associated with wood or jordisite and the heavier values for all other pyrite may indicate a single period of bacterial activity and H_2S production. Independent proof of the biogenic origin of these deposits is furnished by the carbon isotopic composition of epigenetic calcite intimately associated with organic material. The similarity of the $\delta\ ^{13}C$ values of calcite associated with asphalt and coalified wood showed that the anaerobes lived on both. The heavier isotopic composition of most of the other epigenetic calcites indicated some contamination by sedimentary carbonate in the ground water during calcity precipitation. The oxygen isotopic composition of some of the epigenetic calcite was lighter than any $\delta\ ^{18}O$ values yet reported for carbonates. Either anaerobes also fractionate oxygen isotopes or the calcite was precipitated from periglacial waters, indicating that the uranium mineralization is Pleistocene. (auth)

HEALTH AND SAFETY

See also BIOLOGY AND MEDICINE — Radiation Hazards and Protection.

Refer also to abstracts 21791, 22428, 22552, 22557, 22562, 22582, 22583, 22687, 23341, 23991, 24087, and 24163.

22588 (AD-602677) VULNERABILITY TO NUCLEAR ATTACK OF THE WATER TRANSPORTATION SYSTEMS OF THE CONTIGUOUS UNITED STATES. Benjamin V. Andrews and Harvey L. Dixon (Stanford Research Inst., Menlo Park, Calif.). May 1964. Contract OCD-OS-63-149. 195p. $5.00(CFSTI).

An analysis was made of the vulnerability of the U. S. domestic water transportation systems to nuclear attack. The basic analytical procedure was to develop inventory data, assess the damage to the inventory for a range of nuclear attacks, identify those parts of the water transportation systems that appeared most vulnerable to nuclear attack, and suggest means to reduce the vulnerability. This basic procedure was followed for the four major components of the water transportation systems: (1) waterways, (2) vessels, (3) terminals, and (4) personnel. Statistical data are provided in the appendixes for each of these components. (auth)

22589 (AECL-2154) THE MEASUREMENT OF HIGH LEVELS OF RADIATION EXPOSURES. A REPORT OF METHODS AT THE CHALK RIVER NUCLEAR LABORATORIES. G. Cowper (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1965. 13p. (SM-56/29; CONF-650302-3). Dep.; $0.50(AECL).

From IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna.

Health physics problems involved in the measurement of high levels of radiation exposure during and following a radiation accident are discussed. Radiation detectors and instruments used for personal and area dosimeters and warning devices are described briefly. The importance of reliability of alarm systems is stressed. It is pointed out that in any situation where workers may be exposed to unsealed radioactive substances care must be taken to ensure that the hazard is recognized and that monitoring is arranged accordingly. At the time of a radiation accident workers should be warned of unsafe conditions and the approximate dose received by those exposed should be ascertained, personal and area monitoring should be provided so that clean up work can proceed safely and efficiently, and clean up operations should be supervised for the accurate control of radiation exposure of those engaged in these operations. (C.H.)

22590 (CLOR-34) ANALIZA STANU OCHRONY PRZED PROMIENIOWANIEM W PRACOWNIACH IZOTOPOWYCH W POLSCE W LATACH 1958-1963. (The Evaluation of Radiological Protection Conditions in Isotope Laboratories in Poland, in 1958-1963). T. Musialowicz, S. Dyz, J. Jakubiak, and Z. Wanat (Centraline Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1964. 34p. Dep.

On the basis of supervisory activities of the Central Laboratory for Radiological Protection, the radiation protection conditions in radioisotope laboratories are evaluated. During the period 1958 to 1963 considerable improvement of conditions was found. In the years 1958 to 1961 the most important problem was the situation in establishments using radioactive luminous compounds. At present, the limitation of doses received by the workers employed with radium applicators, is the major radiation protection problem. (tr-auth)

22591 (CONF-641201-16) IMPACT RESISTANCE OF CASKS. H. G. Clarke, Jr. (Franklin Inst., Philadelphia, Pa.). [1963]. Contract AT(30-1)-1484. 41p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

From American Institute of Chemical Engineers Annual Meeting, Boston.

Results from experimental studies designed to reveal the effects of impacts on containers for irradiated fuel are presented along with quantitative data for improved mechanical design of such containers. The techniques of dimensional analysis were employed to show that if a model and a prototype cask were geometrically similar, made of identical materials, and were subjected to impact at equal velocities, they would undergo identical strains unless the stress-strain relations of the materials depended upon rate of straining. Lead casks were used. The results showed that corner or edge impacts are most likely to cause rupture of the outer shell. An edge impact in the closure region is particularly damaging; hence special measures are needed to protect the cover. (P.C.H.)

22592 (CONF-641207-5) REGULATIONS AND CONTROL FOR RADIATION PROTECTION. Paper No. 64-819. Milo D. Voss (Ames Lab., Iowa State Univ. of Science and Tech.). [nd]. Contract [W-7405-eng-42]. 19p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Society of Agricultural Engineers, Winter Meeting, New Orleans.

It is pointed out that with the benefits to be derived from the use of radiation and radioisotopes the user must accept the responsibility for the safe handling of these radioactive materials and radiation machines. Regulations of Federal Agencies and state governments in the U. S. covering the use of radioactive materials are reviewed and sources of material on radiation protection are listed. The hazards of radiation exposure from external and internal sources are reviewed and basic principles of radiation protection are discussed. (C.H.)

22593 (JINR-P-2008) OTSENKA DOZY PRI SLUCHAINYKH OBLUCHENIYAKH CHASTITSAMI VYSOKIKH ENERGII V ZNACHITEL'NYKH KOLICHESTVAKH. (Estimation of the Dose of an Accidental Radiation by a Large Amount of High-Energy Particles). M. M. Komochkov (Joint Inst. for Nuclear Research, Dubna (USSR)). 1965. 8p. Dep.(mn).

An experimental method is suggested for estimating the accidental radiation dose for the staff working at big proton accelerators. The method consists in the measurement of the induced radioactivity of a human body radiated by high-energy particles. Under favorable conditions the sensitivity of the method is several hundreds of milliradians. (tr-auth)

22594 (NP-14976) GRAVITY VENTILATION OF UNDERGROUND SHELTERS. Technical Report R 367. J. C. King (Naval Civil Engineering Lab., Port Hueneme, Calif.). Mar. 1965. 26p.

Tests were conducted to determine the suitability of using gravity ventilation as an emergency method of providing air for survival in an underground shelter. The tests consisted of inducing through a simulated test shelter an airflow caused by inside-outside temperature differentials, and stack heaters in the exhaust duct. An additional test was made which involved a device to direct wind into the intake duct. It was found that wind blowing over the inlet and exhaust ducts created a negative pressure in the shelter that could not be satisfactorily overcome by the gravity methods used; thus, minimum ventilation rates could be obtained only when there was no wind blowing. In the tests conducted to utilize the wind, an NCEL-designed air inducer which mounts on the inlet duct provided satisfactory ventilation during normal weather conditions when there was a wind of 6 to 8 mph. (auth)

22595 (ORNL-3776) NUCLEAR SAFETY PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING

DECEMBER 31, 1964. (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 139p. Dep.; $5.00(cy), 3(mn) CFSTI.

Information is included on 14 topics; a separate abstract was prepared for each. (J.R.D.)

For abstracts of individual sections see: 22096, 22162, 22163, 22458, 22459, 22460, 22461, 22596, 22597, 22598, 22599, 22600, 22989, and 23997.

22596 (ORNL-3776(p.70-4)) SIMULATION OF HIGH-BURNUP UO_2 FUEL IN THE CONTAINMENT MOCKUP FACILITY. G. W. Parker, C. J. Barton, and W. J. Martin (Oak Ridge National Lab., Tenn.).

Attention was given to the problem of simulating fission products other than I_2. A fuel specimen was prepared that simulated irradiated UO_2 fuel with a burnup of 10,000 Mwd/t. The calculated amounts of the inactive elements I_2, Cs, Te, Sr, Ru, and Mo, along with millicurie amounts of tracer isotopes of each element, were mixed with finely divided UO_2 (100%, <11 μ diam). The mixture was pressed into two 10-g pellets which were placed in a stainless steel can and melted in air. The resulting aerosol was transferred to the CMF containment tank filled with a steam-air mixture at 27 psig. The aerosol was allowed to age in the tank for 3.5 hr and then was passed through a complex filter pack for sampling. Results of this experiment have not been completely evaluated, and an experiment with high-burnup UO_2 fuel under strictly comparable conditions has not been performed. Release values obtained for I_2, Cs, and Sr were comparable to those from high-burnup UO_2 fuel, but discrepancies were found in Ru and Te release values that have not yet been resolved. The airborne Cs and Te were efficiently retained by filters, and the roughing filter gave a decontamination factor of 400 for Cs and 8 for Te. The latter value was much lower than for the high-burnup fuel experiment. The results of this experiment are considered encouraging. The validity of the simulation can be more fully evaluated after results of an experiment with high-burnup fuel under conditions strictly comparable to those employed in the simulation run became available. (auth)

22597 (ORNL-3776(p.74-6)) DESIGN OF THE CONTAINMENT RESEARCH FACILITY (CRF). G. W. Parker and C. J. Barton (Oak Ridge National Lab., Tenn.).

A new facility is being designed for installation in one of the hot cells in Building 4501. The facility will have the following features: (1) a fission product aerosol generator for testing 100-g quantities of high-burnup material to the melting point of UO_2 and at intermediate temperatures, (2) a primary vessel that can be tested to 800°C, (3) a 1000-gal pressurized containment shell that can be supplied with various interior surfaces, and (4) provision for simulation of top or bottom breaks in the primary vessel. (auth)

22598 (ORNL-3776(p.76-103)) BEHAVIOR OF RADIOIODINE IN THE NUCLEAR SAFETY PILOT PLANT. L. F. Parsly, C. J. Barton, C. Brashear, L. F. Franzen, P. P. Holz, T. H. Row, and J. L. Wantland (Oak Ridge National Lab., Tenn.).

The results of four experimental runs and partial results of a fifth run are reported. In three runs, only iodine was released into the model containment vessel; in the other two, iodine was released by melting a stainless-steel-clad UO_2 dummy fuel element containing iodine. The iodine-only runs were intended to determine if iodine behavior was influenced by the aerosol generated by the plasma torch, by comparing iodine behavior after release with and without using the torch. The results show that iodine deposition in these experiments occurred more slowly in the runs where the plasma torch was used. The nature of the plasma effect has not been identified; the iodine appears not to be associated with particles. In the other two runs, where iodine was released in the presence of UO_2, more rapid iodine deposition occurred. The results of these runs confirm the conversion of a significant fraction of the iodine to compounds other than I_2. In addition to behavior of the iodine in the containment, deposition on different materials was studied. Experience in decontaminating the equipment is also reported. The development of plasma melting techniques, and hardware for remote sampling of the radioactive aerosols is discussed. (auth)

22599 (ORNL-3776(p.109-25)) SIMULATED LOSS-OF-COOLANT ACCIDENTS IN THE ORR. W. E. Browning, Jr., C. E. Miller, Jr., R. P. Shields, B. F. Roberts, J. G. Wilhelm, W. H. Montgomery, and O. W. Thomas (Oak Ridge National Lab., Tenn.).

In-pile experiments are being continued to study the characteristics and behavior of fission products released by melting or vaporizing miniature stainless-steel-clad UO_2 fuel elements in the ORR in a variety of atmospheres. Comparisons were made of results of experiments employing atmospheres of dry helium, moist helium, steam-helium-hydrogen, dry air, moist air, and steam air. The appearance of the fuel residue was affected markedly by the type of atmospheric environment. The presence or absence of stainless steel droplets appears to be a sensitive indicator of the oxidation-reduction state of the environment in which fission products are transported. The distribution of iodine, cesium, rubidium, and strontium in the various regions of the experiments was determined. Interpretation of the iodine data from in-pile UO_2 melting experiments leads to the conclusions that: a major fraction of released iodine stops on metal surfaces although this deposition is inhibited according to the amount of moisture in the atmosphere; particulate filters effectively stop iodine released in all atmospheres investigated except moist air; 50% of the iodine normally found in the first filter was found in the condenser in experiments in which steam was a component of the atmosphere; 0.5% of the total iodine found penetrates the first layer of charcoals; only 0.0001% of the iodine found in each of these experiments penetrated the filter system, in-pile charcoal trap, and outlet tubing. A facility designed and built in the ORR to provide high-burnup fuel for the in-pile UO_2 melting experiments is being used to irradiate UO_2 capsules to approximately 21,000 Mwd/t. Seven capsules can be irradiated simultaneously to provide a supply that will permit future meltdown experiments to study the effects of burnup. This facility and the additional equipment required to perform hot-cell assembly of the experimental apparatus are described. (J.R.D.)

22600 (ORNL-3776(p.129-32)) NUCLEAR SAFETY INFORMATION CENTER. J. R. Buchanan, W. B. Cottrell, and S. P. Hendrix (Oak Ridge National Lab., Tenn.).

The Nuclear Safety Information Center, now in its second year of operation, has collected, evaluated and stored about 4100 documents or sources of nuclear safety information. Several hundred of the latest references were placed on magnetic tape to be processed and issued early in 1965 and the first of a quarterly indexed bibliography of the center's accessions. The report Current Practices in the Release and Monitoring of ^{131}I at NRTS, Hanford, Savannah River, and ORNL was issued by the Center, and the report Behavior of Iodine in Reactor Containment Systems was submitted for publication. Other state-of-the-art studies are in various stages of development. The Center operated exhibits at the Third International Conference on the Peaceful Uses of Atomic Energy at Geneva, Switzerland, August 30–September 10, 1964, and at the Atomfair in San Francisco, California, December 1–3, 1964. (auth)

22601 (ORNL-TM-1068) MULTIPLANT RADIATION EMERGENCY DRILL, OAK RIDGE NATIONAL LABORATORY, OCTOBER 20, 1964. G. C. Cain and J. H. Greene (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 56p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A multiplant radiation emergency drill at Oak Ridge National Laboratory, Oct. 20, 1964, is described. The performance of local emergency squads, emergency service units, emergency equipment, and communication systems was evaluated. Employee reactions in handling a local radiation incident which developed into a large-scale incident involving several facilities and a large number of employees were also evaluated. (C.H.)

22602 (RISO-94) INVESTIGATION OF SOME FILTRATION PROBLEMS IN A HIGH-ACTIVITY HANDLING BUILDING. I. RADIO-IODINE AND -CAESIUM SAMPLING FROM THE VENTILATION AIR OF A HIGH-ACTIVITY HANDLING BUILDING. II. THE PARTICLE-FILTRATION EFFICIENCY OF INSTALLED FILTERS IN THE HIGH-ACTIVITY HANDLING BUILDING 459 AT HARWELL. Hans Flyger (Atomenergikommissionen, Risø (Denmark). Forsøgsinstitut). Nov. 1964. 24p. Dep.(mn).

I. The efficiency of different filters towards radioiodine and -cesium in the ventilation air from a high-activity handling building is reported. The iodine activity was released during the processing of a rig containing uranium carbide and was drawn through a 10 cm bed of granulated activated carbon before it was sampled. Millipore and glass-fiber filters and charcoal paper were used. Data are tabulated. II. An estimate of the size distribution of dust particles present as permanent atmospheric impurities in the intake air of the high-activity handling building is also given. An attempt was made to evaluate the particle-filtration efficiency of an installed filter bank from a combination of this estimate with a filtration theory and a photoelectric counting of the numbers of particles present at the same time on either side of the filter bank. A comparison of the results found with corresponding methylene-blue test results led to a refinement of the final analysis. Photoelectric countings of the particle numbers in the air inside the ventilation system handling the air from the high-activity handling cells showed conspicuously the presence of 100 times the number of particles that are present in the air entering the building. (P.C.H.)

22603 (TID-18968) BIBLIOGRAPHY OF PUBLICATIONS CONCERNING EFFECT OF NUCLEAR EXPLOSIONS. Bibliography 1945-1961. (Atomic Bomb Casualty Commission, Hiroshima (Japan)). Contract AT-49-1-GEN-72. 22p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

References (206) are given to U. S. and foreign journals and reports published from 1945 through 1961. The references are arranged according to year of publication. Separate author and subject indexes are included. (P.C.H.)

22604 REDUCTION OF PERSONNEL EXPOSURE IN THE NORWEGIAN RADIUM HOSPITAL 1954-1963. Per Grande and Ragnar Jahren (Norwegian Radium Hospital, Montebello, Norway). Acta Radiol., Therapy, Phys., Biol. (N.S.), 3: 12-16(Feb. 1965).

Exposure curves for the personnel at the Norwegian Radium Hospital for the period 1954-1963 are presented. The progressive improvement in radiation hygiene, and the means by which it was attained, are discussed. (auth)

22605 SOME OBSERVATIONS ON THE NATURE AND PARTICLE SIZE OF AIRBORNE PLUTONIUM IN THE RADIOCHEMICAL LABORATORIES, HARWELL. R. J. Sherwood and D. C. Stevens (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Ann. Occupational Hyg., 8: 93-108(Mar. 1965). (AERE-R-4672)

A number of samples of airborne dust taken in areas in which plutonium is processed were autoradiographed and examined microscopically to determine the size and activity distributions of the active dust. Although the median particle activity was often as little as 10^{-2} dpm, the spread of activity observed was enormous; in about one half the samples the greater part of the sample activity could be attributed to a single particle whose activity was as much as 10^4 or 10^5 times the mean. Frequently the plutonium was attached to inert particles, either spread uniformly over the surface, or more commonly located at a single point, suggesting the adherence of fine active particles to the larger inactive particles which were visible under the microscope. The contaminated particles were commonly found to be of a size unlikely to penetrate deeply into the lungs, so that their radiotoxicity is uncertain. (auth)

22606 DATING OF NUCLEAR EXPLOSIONS BY MEASURING GROSS BETA ACTIVITY IN PRECIPITATION. C. B. Senvar (Univ. of Ankara). Atompraxis, 11: 144-6 (Mar. 1965). (In German)

Total beta activity measurements in snow water were utilized to determine the explosion date of the largest Russian nuclear test in 1961. The Wax and Wigner formula with an exponential of 1.25 was found to be most acceptable for the accurate dating of a nuclear test. (auth)

22607 LIMITATION OF THE POPULATION DOSE IN THE CASE OF A MCA. E. Sauter (Siemens-Schuckertwerke AG, Erlangen, Ger.). Atomwirtschaft, 10: 126-9 (Mar. 1965). (In German).

For setting the acceptable emergency dose to the population in the case of the maximum credible accident (MCA) two authorities received acceptance: The International Commission on Radiological Protection (ICRP) and the British Medical Research Council (BMRC). A radiation dose of about 20 to 30 r once in a lifetime was fixed as the acceptable emergency dose. A comparison of the figures specified by the two organizations showed that the iodine dose given by the BMRC is essentially smaller than the corresponding value of the ICRP. The latter refers, it is true, to persons of all age groups while the maximum dose proposed by the BMRC applies to adults. The Federal Minister for Scientific Research accepted the proposal of the BMRC in respect of the reactor accident doses judged as acceptable and additionally recommended: the evacuation, if the radiation dose exceeds 3 rem, of children, expectant mothers, and other persons whose presence is unnecessary in the zone affected by the accident and who can be easily moved, the issuing of a warning against the consumption of contaminated food or the banning of its sale if the contamination is greater than that permitted by the IAEA Radiation Protection Standards. (auth)

22608 ON THE REMOVAL OF RADIOACTIVE SURFACE CONTAMINATIONS. Yasushi Nishiwaki and Hajime Nishioka. Bull. Tokyo Inst. Technol., No. 61, 13-28(1964).

For removing radioactive contaminants from various surfaces, chelating agents and surfactants were used. It was found that the combined use of the chelating agents and the surfactants is particularly effective in decontaminating surfaces of glass, cotton textiles, and foliage. The possibility of removing not only the surfaces of foliages but also some of the internally incorporated radioactive contaminants by the combined use of the chelating agents and the surfactants is discussed. (M.C.G.)

22609 III. SHORT-TERM AND LONG-TERM EFFECTS. B. THE LONG TIME EFFECTS OF NUCLEAR WAR. R. R. Newell (Stanford Univ., Palo Alto, Calif.). Conn. Med., 28: 207-11(Mar. 1964).

The most important long-time effect of a nuclear war will be the enduring disruption of social organization. The death of large numbers of key personnel itself will cause the destruction of our civilization. Next to its capability for destruction, nuclear bombing is characterized by the amount of radiation it produces and the radioactivity it leaves behind. The enduring hazards to health from the radioactivity will be mostly from the long-lived nuclides, ^{90}Sr, ^{137}Cs, and ^{14}C. (During the actual fallout, the external irradiation is most important.) Among the late sequelae of irradiation are leukemia, cancer, shortening of life-span, and genetic mutations. Radiation is leukemogenic, as proved in experimental animals and observed among survivors of the Hiroshima and Nagasaki bombing. It is estimated that the 1 R exposure of 100,000,000 persons would produce two or three extra cases, an increase of less than 0.01% of natural leukemia incidence. Among the Hiroshima and Nagasaki survivors, some carcinogenesis has become evident, but with a long latent period compared to leukemia. It may eventually add up to a larger total than the leukemia. Genetic effects of radiation are also considered. Whatever mutations do occur, spontaneously or induced by irradiation, may die out or may proliferate and spread through the population. It is pointed out that a mutation that does only a little harm is really more damaging than one that does a lot of harm, for the latter will soon be eliminated from the population by differential mortality. It will be many generations before the slightly harmful gene falls into a genetic complex where

its effects are critical and lead to death or sterility. Thus, every mutation put into the race requires an early death in some future generation to get it out again. However, it is impossible to say whether an increase in the mutation rate with consequent increase in variability of the human race is bad for mankind, or good. (BBB)

22610 CONTAINERS FOR RADIOACTIVE MATERIALS. Engineer, 219: 277(Feb. 5, 1965).

Containers were developed for transporting radioactive or fissile material. They have an inner vessel of dense radiation-resistant material (lead), a thermally insulating casing (hardwood or Celotex board), and an enclosing canister of fire-resistant material (mild steel). In one design the inner vessel is surrounded with a resin, which can act as a matrix for a uniformly distributed moderator and shielding materials, such as borax and lead shot. (M.C.G.)

22611 THE RADIATION CONTROL IN ESTABLISHMENTS. I. THE CASE OF THE INSTITUTE OF PHYSICAL AND CHEMICAL RESEARCH (TOKYO). Kazunari Igarashi (Inst. of Physical and Chemical Research, Tokyo). Genshiryoku Kogyo, 10: No. 4, 70-4(Apr. 1964). (In Japanese)

In the Institute, 24 of the 45 rooms are concerned with radiation. The radioactive facilities of the Institute are a 26-inch cyclotron, a Van de Graaff accelerator, two Co-60 irradiation facilities using 2000 curies and 250 curies, a test room for radioisotopes, a test room for nuclear fuels, and an x-ray-diffraction apparatus, etc. The Radiation Control Group handles measurements of beam intensities, personnel radiation control, decontamination, disposal of radioactive wastes, etc. The Institute will move to Asaka outside Tokyo in the near future. (NSA of Japan)

22612 RADIATION CONTROL IN ESTABLISHMENTS. PART II. THE PRESENT STATE OF RADIATION CONTROL AT THE TOKYO METROPOLITAN ISOTOPE CENTER. Atsushi Nukasawa (Tokyo Metropolitan Isotope Center). Genshiryoku Kogyo, 10: No. 5, 70-4(May 1964). (In Japanese)

The Tokyo Metropolitan Isotope Center has many buildings with a total floor area of more than 3600 m^2 on a small site of about 10000 m^2. The radiations used, or radioactivity in the Center, are increasing year after year, and the types and their uses are also being changed. The present problems in the radiation control concerns the personnel. Described are (1) the radiation control areas, (2) the personnel radiation control, (3) laboratory, building, etc., radiation control, (4) waste disposal for solid, liquid, and gas wastes, and (5) countermeasures for emergency accidents. (NSA of Japan)

22613 RADIATION CONTROL IN ENTERPRISES. VII. COLLECTIVE ISOTOPE LABORATORY OF THE DAIICHI SEIYAKU CO., LTD. Hiroshi Ogawa (Daiichi Seiyaku Co., Ltd., Japan). Genshiryoku Kogyo, 10: No. 10, 65-7(Oct. 1964). (In Japanese)

Many different labeled compounds and other medical compounds, using ^{3}H, ^{14}C, ^{131}I, etc., are produced by the company. The collective isotope laboratory in the Yanagishima factory is in an isolated concrete building, and is equipped with 12 hoods, and 3 glove boxes. To protect the personnel from external irradiation, shieldings of lead, and lead glass, and remote control systems are used. Radiation doses of the personnel are checked with film badges, pocket chambers, etc. In the internal exposures of the personnel, careful measures and precautions are also taken. Due to the careful handling of radioisotopes by the personnel, the contamination of the laboratory has been held to a minimum. Contaminations of rooms, tools, instruments, etc. are checked every Saturday. The waste disposal, medical checks, and other protective procedures are also described. (NSA of Japan)

22614 RADIATION DOSIMETRY FOR PROTECTION PURPOSES NEAR HIGH-ENERGY PARTICLE ACCELERATORS. J. Baarli and A. H. Sullivan (CERN, Geneva). Health Phys., 11: 353-61(May 1965).

The basic interactions occurring when very high-energy radiation passes through matter are briefly reviewed. It was concluded that dosimetry near high-energy accelerators involves the measurements of a mixed field composed of proton, neutron, pion, and gamma radiation as well as electrons and muons, all covering a very wide energy range. The methods of measuring the Rem dose in these radiation fields, using existing instrumentation, falls into two categories according to the dose-rate. Above 10 MRem/hr, the tissue-equivalent ionization chamber in combination with a parallel plate chamber for quality factor measurements can be used. At lower dose-rates the sensitivity of these chambers limits their use and a system of six different instruments is required. This system enables the evaluation of the contribution to the total dose from slow and fast neutrons, high-energy particles, and gamma rays. Results of measurements using both these systems are presented for measurements in beams and behind shields of the CERN 600-Mev Synchrocyclotron and the 28-Bev Proton Synchrotron. Behind thick shields in experimental regions of the PS machine, 11–22% of the total Rem dose is caused by slow neutrons, 50–76% by fast neutrons, 2–25% by high-energy radiation, and 2–20% by gamma radiation. (auth)

22615 GAMMA-RAY ENERGY AND ANGULAR DISTRIBUTIONS ABOVE FALLOUT. R. L. French (Radiation Research Associates, Inc., Fort Worth, Texas). Health Phys., 11: 369-83(May 1965).

Detailed data on the gamma radiation environment in air 3 ft above fallout uniformly distributed on a smooth ground surface were calculated using Monte Carlo techniques. The basic data give the energy and angular distributions of the direct-beam and the scattered photon flux above monoenergetic plane isotropic gamma sources for ten different source energies from 0.10 to 3.5 Mev. For each source energy, the flux arriving at the receiver in each of ten energy intervals between 0.04 and 3.5 Mev and eighteen equal receiver angle intervals between 0° (nadir) and 180° (zenith) was calculated. The dose arriving through each 10-degree interval of receiver angle was also computed. To illustrate their application, the results of the monoenergetic calculations were weighted and combined to obtain energy and angular distribution of the photon flux from fallout of four different ages: 1.12 hr, 23.8 hr, 4.57 days, and 9.82 days. Comparisons with measured and previously calculated data, both for actual fallout fields and for simulated infinite plane sources, show favorable agreement. (auth)

22616 ANALYSES OF ENVIRONMENTAL SAMPLES FOR CARBON-14 AND TRITIUM. J. C. Drobinski, Jr., D. P. La Gatta, A. S. Goldin, and J. G. Terrill, Jr. (Dept. of Health, Education and Welfare, Winchester, Mass.). Health Phys., 11: 385-95(May 1965).

The levels of carbon-14 and hydrogen-3 (tritium) in various types of environmental samples collected over the period January 1963 to April 1964 were measured. Sample types included composite foods (total diets), individual food items, atmospheric carbon dioxide, and human and animal organs, tissues, and fluids. Data are tabulated. (auth)

22617 RINGOLD FARMS—A HANFORD ENVIRONMENTAL STUDY. I. C. Nelson and R. F. Foster (General Electric Co., Richland, Wash.). Health Phys., 11: 397-401 (May 1965). (HW-78262(Rev.))

In mid-1962, Hanford's whole-body counter was made available for environmental studies. The twenty inhabitants of a small, well-defined, farming area, which is closest to the production facilities at Hanford, were chosen for study. Late in 1962, twelve of these people were examined in the whole-body counter and four persons provided urine for bioassay analysis. Simultaneous measurements were made with a 9-in. diameter by 4-in. thick NaI crystal and a 3-in. diameter by 3-in. thick NaI thyroid monitor. The radionuclides detected were potassium-40, zinc-65, cesium-137, and iodine-131. The quantity of zinc-65 ranged from 4 to 82 nC on the twelve individuals examined. The quantity of cesium ranged from 1 to 10 nC. Thyroid burdens of iodine-131 ranged from less than 30 to 300 pC. Phosphorus-32 was found in the urine, and ranged from 0.1 to 0.2 nC $^{32}P/l$. The source of iodine-131 and cesium-137 was primarily

world-wide fallout from nuclear detonations. Zinc-65 and phosphorus-32 are radionuclides identified with cooling water from the Hanford reactors. These radionuclides enter the food chain in irrigation water drawn from the Columbia River. The principal mode of exposure was through ingestion of milk and other farm produce. The individual whole-body counter examination results indicated the presence of less than 2% of the maximum permissible body burden established by the NCRP. Thyroid dose estimates ranged from 20 to 80 MRads/year for the individuals having measurable radioiodine burdens. (P.C.H.)

22618 ROUGH ESTIMATES OF BETA DOSES TO THE SKIN. W. G. Cross (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Phys., 11: 453-4(May 1965).

A rule-of-thumb is suggested for the skin dose rate at short distances from an exposed beta point source of known strength. It is intended to apply particularly to situations where people are manipulating sources within a few centimeters of their hands, as, for instance, in the chemical preparation of such sources. The basis of the estimate is that, over the range of beta energies of practical importance, the dose per disintegration from a point source at short distances in air is independent of end-point energy to within a factor of 2 or 3. The proposed rule-of-thumb for sources emitting one beta particle per disintegration is: a 1 mC point source gives a skin dose rate of 5 Rad/hr at 10 cm. An almost equivalent expression, easier to remember, is: a 1 mC point source gives a skin dose rate of 1 Rad/min at 1 in. (P.C.H.)

22619 ^{137}Cs IN ALASKAN ESKIMO HAIR. T. M. Beasley and H. E. Palmer (General Electric Co., Richland, Wash.). Health Phys., 11: 454(May 1965). (HW-SA-3706)

Hair samples ranging from 1-15 g were obtained from both adult male and female Eskimos at Anaktuvuk Pass, Alaska, whose ^{137}Cs body burdens from 1963-1964 ranged from 0.3 to 1.0 μC. Each of 20 hair samples measured showed detectable amounts of ^{137}Cs. When compared to the ^{137}Cs body burdens, male hair samples gave concentrations ranging from 3-8 dpm/g of hair/μC ^{137}Cs in the body while values for the female hair samples showed less consistency and ranges of 1-20 dpm/g of hair/μC ^{137}Cs in the body. (P.C.H.)

22620 THE ROLE OF THE SOUTHERN INTERSTATE NUCLEAR BOARD IN RADIATION PROTECTION. Robert H. Gifford (Southern Interstate Nuclear Board, Atlanta) and Maxwell Dauer. Ind. Med. Surg., 34: 147-50(Feb. 1965).

Projects under the Southern Interstate Nuclear Board's Operational Plan for 1964 are discussed. These included a study for the Atomic Energy Commission on the radiation pasteurization of fruits grown in the South; a program with the Bureau of Public Roads for the application of radiation to highway construction; projects with the National Aeronautics & Space Administration on the utilization of spin-off technology; a special pilot study for the Area Redevelopment Administration on applications of technology to new and existing industry in the City of Charleston, West Virginia; coordinated studies with the AEC on conversion and use of Federal facilities for private industry; a technician training project coordinated with state and national labor programs; and a coordinated program with the Office of Emergency Planning and the Oak Ridge National Laboratory in civil defense. (C.H.)

22621 TASK AND WORKING METHOD OF THE "INSPECTIE VOOR DE HYGIENE VAN HET MILIEU." III. RADIOACTIVITY. G. Seegers. Ingenieur (Utrecht), 76: G33-5(Dec. 11, 1964).

The statutory regulations of the Domestic Health Service for the control of radioactivity in the Netherlands are discussed. (RCN)

22622 THE NEED FOR RESEARCH PROGRAMS TO PROVIDE DATA APPLICABLE TO THE ESTIMATE OF MAXIMUM PERMISSIBLE EXPOSURE VALUES FOR INTERNALLY DEPOSITED RADIONUCLIDES. Karl Z. Morgan (Oak Ridge National Lab., Tenn.). J. Nucl. Med., 6: 79-92(Feb. 1965).

More is known about radiation hazards, and the maximum permissible exposure (MPC) values for radionuclides are probably more reliable than for many of the common chemical agents. However, much remains to be done before great reliance can be placed on any of the MPC values. Many new radionuclides are being produced and becoming available in a great variety of chemical and physical forms. Both animal and human studies should be conducted with all of the more common chemical forms of the radionuclides in order to establish acceptable MPC values and to make it possible to weigh the benefits in their use against the hazards they may produce to man and his environment. (auth)

22623 DECONTAMINATION OF CATIONIC RADIOACTIVE ISOTOPES BY CATIONIC SURFACTANTS. Yoshiki Wadachi (Japan Atomic Energy Research Inst., Tokyo), Kazuo Takada, Yoshito Yamaoka, and Syun Noguchi. J. Nucl. Sci. Technol. (Tokyo), 2: 104-7(Mar. 1965).

The decontaminating mechanism of the cationic radioactive isotopes $^{60}CoCl_2$ and $^{45}CaCl_2$ by the cationic surfactants dodecyl benzyl dimethyl ammonium chloride and cetyl pyridinium bromide was studied by means of washing and paper chromatographic experiments. A reference experiment was also carried out with sodium dodecyl sulfate to compare the effect of the above cationic surfactants with anionic ones. These experiments indicated that micelle formation was indispensable for the anionic surfactant, while this was not necessary for the cationic surfactant, since the monomer contributed to the decontaminating process. This means that the ionic process assumes a very important role in the decontamination of cationic radioactive isotopes by cationic surfactants in the absence of fatty soils. (auth)

22624 THE HEALTH PHYSICS DIVISION OF THE JULICH NUCLEAR RESEARCH ESTABLISHMENT. M. Keller, W. Schroeck-Vietor, and R. Tzschaschel (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 109-13 (Mar. 1965). (In German).

Problems of radiation protection are reviewed, using the Health Physics Division of the Jülich Nuclear Research Establishment as an example. Problems of environmental survey, personal dose control, and radiation protection in the different institutes of the Establishment are described. (auth)

22625 CESIUM-137 IN MILK WITH SPECIAL REFERENCE TO SCHOOL FEEDING. Noboru Yamagata and Kiyoshi Iwashima (Inst. of Public Health, Tokyo). Koshu Eiseiin Kenkyu Hokoku, 13: 159-61(Sept. 1964).

Evaluation was made of the possible increase in the daily intakes of cesium-137 by school children fed by milk at public expenses. Average daily intake through milk for the period January-September 1963 was shown to be 17 $\mu\mu c$. The levels of cesium-137 were almost the same in milk produced in this country and imported from the United States of America. In July-August period in 1963, milk-fed school children consumed more than 50% of cesium-137 in addition to 42.7 $\mu\mu c$ which was taken daily at home. (auth)

22626 DIETARY INTAKES OF FALLOUT RADIOACTIVITIES BY THE RYUKYUANS. Noboru Yamagata (Inst. of Public Health, Tokyo). Koshu Eiseiin Kenkyu Hokoku, 13: 162-9(Sept. 1964).

Collection of foodstuffs in and in the vicinity of Naha City, Okinawa, the Ryukyu Islands, was made to evaluate the daily intakes of fallout radioactivities by people in the beginning of October, 1963. The average Ryukyuans consume less strontium-90 and cesium-137 as compared with the average Japanese who lives in the mainland, 4 to 7.5 pC of the former radionuclide and 16.2 to 43.8 pC of the latter, respectively per diem. Soil analysis indicated that the food-stuffs raised on land in the Ryukyu Islands contain less amount of these radionuclides than in the mainland Japan. Since a considerable part of the foodstuffs consumed in the Islands is imported, the relation between the two methods of estimating the daily intakes of radionuclides by people, namely, the standard recipe method and the

family group method determined for the mainland Japanese could not be applied to the Ryukyuans. (auth)

22627 RADIOACTIVE CONTAMINATION OF THE WORKERS. INTERPRETATION OF THE RESULTS OF MEASUREMENTS, ASSESSMENT OF THE DOSE RECEIVED BY THE TISSUES, AND RECORDING OF THE RESULTS IN PERSONAL MEDICAL. C. Polvani (CNEN, Rome). Minerva Nucl., 8: 367-78(Nov.-Dec. 1964). (In Italian)

The means whereby, with the present status of studies in this field and compatibly with the organisation and technical characteristics of ordinary radiation protection services, the individual radiation exposure dose can be estimated following radioactive contamination of the body and how these data should be recorded in the personal medical documents of each worker are discussed. Cutaneous contamination, submersion of the body in inert radioactive gases, and the retention of inhaled or ingested radioactive nuclides are discussed. The different modes of intake (chronic and acute) and the different types of retention (short or long lasting) are described, in equilibrium or non-equilibrium conditions. The methods for the assessment of retention are analysed critically. After the course of the concentration of the radioactive substances retained in the various organs has been estimated, it is then possible to calculate the absorbed dose. A number of simplified, practical methods for assessing the dose in cases of chronic and acute intake are described. The use of dosimetric indexes indicated as fractions or percentages of the maximum permissible levels is proposed in cases in which information as to a given exposure is not sufficient to allow the dose to be calculated properly. The methods for recording the dose of each worker in personal medical documents are discussed. (Tr-auth)

22628 EXPERIMENTS USING MODELS FOR THE RECOVERY OF DAMAGED SHIPS. Nucl. Powered Ship Res Assoc. Japan, No. 43, 1-47(Aug. 1963). (In Japanese)

Since nuclear-powered ship accidents have great consequences, these ships must be so constructed that, when damaged, the ships may be recovered rapidly. For the experiments performed, models were constructed for the Nuclear Observation Ship of 6500 gross tonnage and an oil tanker of 45000 dead weight tonnage. These two models are divided into sections for the simulation of damages. The purpose of the experiments was (1) to obtain the (static) characteristics of recovery when the ship suffers water leakage in some sections, (2) to observe the ship behavior during the leakage, (3) to find the optimal conditions for recoveries, and (4) to observe the trends of the GN value under the leaking conditions. The results of the experiments performed are given. (NSA of Japan)

22629 SAFETY IN CHEMICAL PROCESSING. Reactor Fuel Process., 8: No. 1, 65-7(Winter 1964-65).

An incident involving a plutonium anion exchange contactor at Rocky Flats is discussed. The process equipment is described, and evidence and findings are analyzed. Certain hazards associated with the use of anion exchange resins in plutonium service are mentioned. On the basis of an investigation of the incident, it is recommended that equipment, such as anion exchange columns where gas evolution is known to occur, should be equipped with rupture disks or other pressure-relief devices. Operating procedures on anion exchange columns should include provision for venting the system during temporary as well as prolonged shutdowns. (P.C.H.)

22630 THE DECONTAMINATION OF SURFACES AND OBJECTS CONTAMINATED WITH RADIOACTIVE SUBSTANCES. COTTON-MADE PROTECTION. III. EXPERIMENTAL PART. C. Licaret, D. Serban, and T. Vlad. Rev. Chim. (Bucharest), 15: 692-5(Nov. 1964).

It was found that good decontamination is given by complexing and detergent solutions in concentrations of 0.30 and 0.25%, respectively. Best results were given by sodium hexametaphosphate and sodium ethylenediaminotetraacetate mixed with solutions of Dero-40, Penetrol, and Alba. Maximum decontamination was given by 3 5-min washing-rinsing cycles. (JPRS)

22631 ENERGY DISCRIMINATION METHOD FOR MEASURING CONCENTRATIONS OF LONG-LIVED ALPHA AEROSOLS. L. V. Artemenkova, V. P. Grigorov, and A. S. Smirnov. Sb. Rabot po Nekotorym Vopr. Dozimetrii i Radiometrii Ionizir. Izluchenii, No. 2, 169-76(1961). (In Russian)

Alpha energies are discriminated in apparatus containing a scintillation counter with a ZnS(Ag) phosphor and an electronic circuit for measuring the output pulse amplitude. The recording apparatus may be simple if high accuracy is not required. A stationary unit for continuous monitoring of atmospheric contamination with the results recorded on a multichannel recorder can be made up from standard pieces of equipment (amplifiers, discriminators, normalizers, and integrating circuits). In another type of equipment that may be used, the absolute counting rate in each channel is measured and the desired value is determined with an operator or a special calculator. The energy-discrimination method is recommended for continuous monitoring of air contaminated with alpha-active aerosols with a sensitivity of 1×10^{-14} to 2×10^{-14} C/l. (TTT)

22632 RADIATION ACCIDENTS AND EMERGENCIES IN MEDICINE, RESEARCH, AND INDUSTRY. Lawrence H. Lanzl, John H. Pingel, and John H. Rust, eds. Springfield, Ill., Charles C Thomas Publisher, 1965. 339p. (CONF-277). $11.75.

Separate abstracts were prepared for fifteen chapters. Ten chapters were abstracted previously and appeared in NSA Vol. 18 as numbers 8546, 9960, 12405, 14104, 15910, 15911, 16269, 16270, 22309, and 22310. (C.H.)

For abstracts of individual chapters see: 22633, 22634, 22635, 22636, 22637, 22638, 22639, 22640, 22641, 22642, 22643, 22644, 22645, 22646, and 22647.

22633 ACTIONS AT THE SITE OF A RADIATION ACCIDENT. Milo D. Voss (Ames Lab., Ames, Iowa and Iowa State Univ., Ames). p.27-32 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

Actions applicable to most radiation accidents are discussed. These include incident termination, exposure control, medical control, support actions, and information release. (C.H.)

22634 SCREENING RADIOACTIVELY EXPOSED PERSONS FOR MEDICAL ATTENTION, DECONTAMINATION OR RELEASE. John H. Pingel (Argonne National Lab., Ill.). p.45-69 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

Procedures are outlined for screening radioactively exposed persons for medical attention, decontamination, or release after accidents involving radioactivity. (C.H.)

22635 EMERGENCY BIOASSAY METHODS. Jacob Sedlet (Argonne National Lab., Ill.). p.70-81 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

Methods for the determination of above-normal amounts of radioactive materials in the body following exposure during a radiation accident are discussed. Whole-body counting is the most satisfactory method and improvised whole-body counters for emergency situations are described. Procedures are described for the radiochemical analysis of blood, urine, and feces for information applicable to estimates of internal contamination. (C.H.)

22636 DECONTAMINATION OF UNINJURED PERSONNEL. R. H. Burr and M. G. Mason (Mallinckrodt Chemical Works, St. Charles, Mo.). p.82-8 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

The decontamination of uninjured personnel after a radiation accident involves the removal of any external radiation source from the body of the individual and the prevention of deposited radioactive material being taken into the body through inhalation, ingestion, or absorption through the in-

tact skin. Decontamination of each affected individual also prevents the spread of radioactive contamination to other areas and other persons. The decontamination effort can also provide pertinent information concerning the type and quantities of radioactive materials involved in the accident. It is pointed out that the setting up of a decontamination facility at the site of a radiological accident requires previous planning and portable equipment. (C.H.)

22637 MEDICAL MANAGEMENT OF CONTAMINATED PERSONNEL WITH WOUNDS OR PERSONS INTERNALLY CONTAMINATED. George L. Voelz (Atomic Energy Commission, Idaho Falls, Idaho). p.89-115 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

The medical management of personnel contaminated as the result of a radiation accident depends upon whether contaminated wounds or internal contamination are involved. Decontamination procedures for wounds are described and decontamination agents suitable for use on the skin are listed. It is pointed out that surgical resection of the wound area is rarely required and is most frequently practiced when ^{239}Pu is the contaminant. Factors that influence the radiation dose from internal emitters are reviewed and the medical management of acute internal radioisotope exposures is discussed in detail. (C.H.)

22638 HOSPITAL PREPAREDNESS FOR HANDLING CONTAMINATED PERSONS REQUIRING MEDICAL CARE. Robert S. Landauer, Sr. (Cook County Hospital, Chicago). p.122-36 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

Problems involved in handling the victims of radiation accidents by hospitals are discussed. It is pointed out that the hospital staff should be familiar with conditions to be expected and that some hospital personnel should be trained in the use of simple radiation survey meters so that the injured can be monitored before admittance. The need is stressed for the availability of some expert in radiological safety for consultation. The department of radiology of most hospitals will have a qualified person on the staff and other qualified persons may be available locally. Decontamination rooms should be equipped and some personnel should be trained in decontamination procedures. It is stressed that the plan for handling radiation accidents should be kept as simple as possible. Data are included on maximum permissible levels of radiation for skin and clothing contamination and a list of suggested supplies and instruments for preparedness programs is appended. (C.H.)

22639 WASTE GENERATION AND DISPOSAL IN EMERGENCY DECONTAMINATION. Richard B. O'Brien (General Electric Co., Idaho Falls, Idaho). p.170-8 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

Emergency decontamination, facility restoration procedures, and waste disposal after a radiation accident or disaster are discussed in general terms. It is pointed out that decisions concerning the recovery effort are based on a comprehensive series of preliminary investigations. Most minor accidents involving radioactive decontamination offer few problems. Waste generation and disposal resulting from the SL-1 reactor accident are reviewed. The total job was completed in a year's time at a cost of over one million dollars and a total radiation dose of about 3480 rads to the skin and 998 rem to the whole body received by 475 individuals engaged in the final recovery phase. It is pointed out that this was a relatively small reactor accident. (C.H.)

22640 PROBLEMS IN HANDLING RADIUM ACCIDENTS AND EMERGENCIES. Theodore Fields (Health Physics Associates, Highland Park, Ill.). p.179-89 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publishers, 1965.

Radium sources are available in a variety of designs and are used in hospitals, clinics, and laboratories. All radium sources should be tested for external contamination of the sealed source upon receipt and periodically thereafter. One person should have custody of radium or radon sources wherever it is used. Current recommendations are outlined for radium storage, leak and wipe tests, record keeping, surveying, decontamination, and personnel monitoring applicable to the routine use of radium sources. Several types of radiation accidents involving radium are discussed. (C.H.)

22641 RADIATION MONITORING AND NON-NUCLEAR WEAPONS ACCIDENTS. William S. Johnson, Sr. (Eberline Instrument Corp., Santa Fe, N. Mex.). p.190-206 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

The non-nuclear detonation of nuclear weapons may result in the scattering of large quantities of ^{239}Pu over sizeable land areas. Such accidents are not a common occurrence and have been investigated thoroughly as a part of specific field operations involving deliberate detonations. Data are presented from large-area radiation survey of Pu-239 contamination conducted during Operation Roller Coaster. The feasibility of using portable and mobile low-energy electromagnetic radiation detection techniques for detecting Pu contamination over extended land surfaces was investigated. A portable gas proportional α counter was the basic instrument used for determining surface α particle contamination and a mobile low-energy α ray detector installation in a conventional panel truck was used for α survey. The detector was a NaI(Tl) crystal with Al window mounted on a photomultiplier tube housed inside a 2-in thick Pb shield mounted with the crystal 30-in. from the ground. Two single-channel pulse-height analyzers, associated amplifiers, a duplex recorder, motor generator, air conditioner, and electronic equipment were located in various compartments in the truck body. All cracks and holes were sealed to eliminate dust. Preliminary evaluation of the data by comparison with data on small areas collected by monitoring teams indicated good performance for the portable survey instruments. (C.H.)

22642 DOSIMETRY AND INSTRUMENTS FOR ACCIDENT SITUATION ASSESSMENT. Howard R. Fish, Jr. (Argonne National Lab., Ill.). p.207-16 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

Radiation detectors and instruments are evaluated as to their value in the assessment of the radiation dose resulting from radiation accidents. Types discussed include personnel dosimeters, film badges, rate meters, alpha detectors, beta detectors, gamma detectors, neutron detectors, warning systems, and accessories. The selection, maintenance, and calibration of radiation monitoring instruments are discussed. (C.H.)

22643 EMERGENCY DOSE CRITERIA FOR RECOVERY OF PERSONNEL AND FACILITIES. Edward J. Vallario and Robert J. Catlin (Atomic Energy Commission, Washington, D. C.). p.217-22 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

Radiation exposure criteria are presented for use in preparing emergency plans applicable to peacetime disaster situations where small numbers of people are exposed and where the affected areas are confined to the immediate vicinity of the incident area. Problems involved in controlling exposure to radiation during rescue and recovery operations are discussed. Specific dose criteria and judgement factors are set forth for actions involving the saving of a human life, actions involving the recovery of deceased victims, and actions involving the protection of health and property. (C.H.)

22644 MANAGEMENT, EMERGENCY ORGANIZATIONS, POLICY AND PLANS; EMERGENCY MANUALS,

TRAINING, DRILLS AND EXERCISES. G. Hoyt Whipple (Univ. of Michigan, Ann Arbor). p.223-8 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

The value of emergency plans, organization, manuals, and training drills in the event of a radiation accident is discussed. (C.H.)

22645 DOCUMENTATION AND REPORTING OF RADIATION ACCIDENTS. Robert G. Gallaghar (Applied Health Physics, Inc., Bethel Park, Penna.). p.236-58 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

The opportunity to obtain valid documentation of facts concerning a radiation accident fades rapidly with time. Plans for the prompt notification of official agencies and the documentation of essential facts should be established as part of the radiation emergency procedure. It is suggested that a battery-operated tape recorder can be very useful for the documentation of information on which later reports are based. Procedures are outlined for initial accident notification of official agencies, management, insurance carriers, and news media; hazards evaluation; requests for assistance; radiation surveys; health physics data; medical reports; obtaining and recording eye witness accounts, photographic documentation; obtaining and documentation of personnel monitoring data and bioassay results; and the release of information to news media. It is pointed out that in the event of a radiation accident the absence of radiation exposure is as important as information on radiation exposure. (C.H.)

22646 EMERGENCY PLANS AT UNIVERSITIES. Paul L. Ziemer (Purdue Univ., Lafayette, Ind.). p.259-70 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

Over 400 universities and colleges in the U. S. hold AEC byproduct material licenses in addition to reactors and x-ray devices. Work with radiation and radioisotopes at universities covers a broad spectrum of kinds, levels, and applications, and emergencies of every conceivable type must be anticipated. Use of the team approach involving the coordinated efforts of health physics, security, fire, medical, and publicity personnel is recommended for handling radiation accidents involving university facilities. (C.H.)

22647 THE ROLE OF THE PUBLIC HEALTH SERVICE IN RADIATION EMERGENCIES. Raymond T. Moore (Dept. of Health, Education, and Welfare, Dallas). p.294-9 of "Radiation Accidents and Emergencies in Medicine, Research, and Industry." Springfield, Ill., Charles C Thomas Publisher, 1965.

The role of the Division of Radiological Health of the Public Health Service in radiation accidents is discussed. It is pointed out that in the event of a radiological accident or emergency, personnel and technical assistance are available to the respective state health departments. The Division of Radiological Health also provides a comprehensive training program in the field of radiological health. (C.H.)

22648 SAFETY MEASURES IN CHEMICAL LABORATORIES. Third Edition. London, Her Majesty's Stationery Office, 1964. 40p. 3s Od net.

Safety organization and safety equipment in chemical laboratories are described. General laboratory operations, some dangerous chemicals, fire risks and burns, electrical hazards and shock, radiation hazards, handling cylinders of compressed gases, dermatitis, toxic chemicals and gases, and treatment of affected persons are discussed. Monitoring of external radiation by use of dosimeters is covered. (M.C.G.)

22649 ATMOSPHERE SAMPLING ENCLOSURE (Engineering Materials). (California. Univ., Livermore. Lawrence Radiation Lab.). 7 drawings. (CAPE-1177)

The enclosure described is used for storing equipment for atmospheric sampling. It is located on a base 20 × 20 × 8.5 in. high and is constructed of steel angles with an 11 gauge mild steel sheet top. The housing is 27.5 in. high, 20 in. sq, and is constructed of steel angles, which are covered with 22 gauge mild steel sheets. There are louvers on three sides of the enclosure. The top lid opens to 105° and is fabricated of steel. (For details, see TID-4100). (M.C.G.)

22650 EMERGENCY AIR SAMPLER (Engineering Materials). (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). 2 drawings. (CAPE-1173)

The air sampler described consists of an annular impactor, assembly to hold filter papers, fan housing, 0.8-hp motor, and a muffler. The fan is driven by the motor and it draws air through the impactor over the filter paper on which radioactive particulates are deposited. When the paper is removed, the particulates can be counted for radioactivity. The equipment is 11 in. high and sets on a 0.25-in. thick Al base 12.37 in. long and 7.5 in. wide. (For details, see TID-4100) (M.C.G.)

22651 A SPACE RADIATION PROTECTION SYSTEM FOR NEAR-EARTH MANNED ORBITAL SPACE STATIONS. Frank L. Bouquet, Jr. (Lockheed-California Co., Burbank). 22p. (CONF-720-28)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Space stations operating in the near-earth environment over the next decade will require protection for personnel from the hazards of high-speed meteoroids and high-energy particles. The thicknesses and weights required for protection for a large 3-spoke space station were computed by means of computer analysis for circular orbits and one-year missions. Although little or no shielding is required at orbital altitudes less than 110 to 125 nm, shielding weights increase rapidly with altitude. The use of helmet, suit, and bunk shielding is determined to be minimum weight under the assumptions of this study. In low-altitude, low-inclination orbits, the shielding requirements are nominal, about 3226 lbs at 260 nm, 29.5°. A broad optimum in the propellant and shield weight is found between 250 and 400 nm altitude. It is concluded that the radiation fields in space during this time period will not prohibit the successful operation of near-earth space stations in low-altitude, low-inclination orbits. (auth)

22652 METHOD SIMULATING THE LOCAL DISTRIBUTION OF THE DOSE RATE OF A RADIOACTIVE RADIATION. (to Total Kommanditgesellschaft Foerstner and Co.). German Patent 1,182,358. Nov. 26, 1964. Filed June 5, 1962.

The local distribution of the dose rate of radiation is simulated by two separated, modulated r-f transmitters and one or more receivers. The main transmitter is keyed by pulses and transmits its frequency to an auxiliary transmitter, which is keyed by this frequency. The receiver that receives the pulses from the main transmitter, as well as from the auxiliary transmitter, controls a pulse generator in such a way that the width of the pulses emitted by this generator depends on the time shift between the pulses received from the transmitters. The pulses from the pulse generator are fed into an integrator. The reading from this integrator is a measure for the simulated dose rate. (Gmelin Inst.)

INSTRUMENTATION

General

Refer also to abstracts 23164, 23546, 23992, 23993, 23994, 24005, 24006, 24007, 24008, 24012, 24013, and 24015.

22653 (BDX-613-67) A SINGLE PULSE PEAK READING VOLTMETER. Anthony F. Schmidt (Bendix Corp., Kansas City, Mo.). Feb. 1965. Contract [AT(29-1)-613]. 77p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Thesis submitted to Kansas Univ., Lawrence.

A circuit consisting of a number of tunnel diodes connected in series and biased from a current source is investigated for use as a single pulse peak reading voltmeter. The composite current-voltage characteristic of the circuit is examined for proper biasing and probable error. Tests on a constructed circuit are discussed, and some limitations on the type of pulses that can be measured are listed. Single pulses with rise times of 0.1 μsec or greater, and widths of 0.1 μsec or greater, are measured to an accuracy of 0.5 volt. (auth)

22654 (CEA-R-2506) SPECTROMÈTRE SUPERHÉTÉRODYNE DE RÉSONANCE PARAMAGNÉTIQUE ÉLECTRONIQUE. (A Superheterodyne Spectrometer for Electronic Paramagnetic Resonance). Jean-Louis Laffon (Commissariat à l'Énergie Atomique, Grenoble (France). Centre d'Études Nucléaires). 1964. 86p. Dep.(mn).

Thesis submitted to Grenoble Univ. (France).

After a few generalities about electron paramagnetic resonance, a consideration of different experimental techniques leads to the choice of a particular type of apparatus. An EPR superheterodyne spectrometer is described in detail. With this apparatus, experimental results have been obtained and some of these are described as examples. (auth)

22655 (CONF-640607(Vol.II)(Paper D-1)) VOID MEASUREMENTS ON THE BASIS OF IMPEDANCE VOID METERS. J. Bjoerkman and S. Rundquist (Aktiebolaget Atomenergi, Studsvik (Sweden)). 10p.

Testing of cold-water void detectors is reported. The detectors are of the impedance type, and operate at frequencies of 1 Mc or 2 kc. (T.F.H.)

22656 (CONF-640607(Vol.II)(Paper D-2)) THE APPLICATION OF THE IMPEDANCE METHOD FOR TRANSIENT VOID FRACTION MEASUREMENT AND COMPARISON WITH THE GAMMA RAY ABSORPTION TECHNIQUE. C. L. Spigt, A. J. J. Wamsteker, and H. F. van Vlaardingen (Technische Hogeschool, Eindhoven (Netherlands). 26p.

A review is given of some methods for void fraction measurement. A detailed description is given of the impedance method and the γ-ray-attenuation method. Results of measurements are given, showing the comparison of both methods and the use of the impedance method for the determination of the void fraction along the height of the channel, both in steady and nonequilibrium conditions. Both methods measure the void fraction without introducing any disturbance in the two-phase flow. (auth)

22657 (CONF-640607(Vol.II)(Paper D-5)) BEHAVIOUR OF IRRADIATED THERMOCOUPLES—THEORETICAL INVESTIGATIONS. S. Moretti (Comitato Nazionale per l'Energia Nucleare, Ispra (Italy)). 24p.

Although experiments have been carried out focused on thermocouple behavior under irradiation, it is almost impossible to find any strictly extrapolative information. This is essentially a result of the fact that all the data reflect the environmental conditions of the experiments. In other words, all the tested thermocouples drifts are dependent upon the particular thermal gradient and nuclear field of each specific experiment, and it would be very difficult to extend the results to other similar thermocouples. Appropriate fundamental rules are established, to be followed in further investigations, in order to be able to generalize the results. The analysis of the behavior of inhomogeneous thermocouples shows that it is possible to interpret the output of any thermocouple, whatever the working temperature and nuclear patterns, provided that there exists for its type a so-called "characteristic map" of irradiated thermocouples. This map consists of a family of curves obtained by pre- and post-irradiation calibration of thermocouples irradiated "uniformly" and "by steps." (auth)

22658 (CONF-640607(Vol.II)(Paper E-1)) IN-PILE APPLICATION OF STRAIN GAUGES. P. S. Weltevreden (European Atomic Energy Community). 19p.

Research on the in-pile application of strain gages is outlined. A concise description of the background of the problem is given, followed by a summary of the available experimental data. Research is discussed. A description of irradiation rigs prepared for the Ispra-I reactor and the High Flux Reactor in Petten is given, together with their out-of-pile equipment. (auth)

22659 (EUR-2281.f) MESURE DU TEMPS DE REPONSE DE THERMOCOUPLES DANS LES CIRCUITS DE METAUX LIQUIDES. (Measurement of the Response Time of Thermocouples in Liquid Metal Circuits). F. Genet and B. Milliot (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 44p. Dep.(mn).

The characteristic time for different types of thermocouples was measured in a flow of NaK alloy with the purpose of possible application to the SORA reactor cooling loops. The measuring methods and the results obtained for 150 tests are reported. The results are in good accordance with the same type of measurement performed with other fluids. (auth)

22660 (HW-83298(p.7.1-30)) INSTRUMENTATION AND NONDESTRUCTIVE TESTING. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

An underwater irradiated-fuel scanning facility was installed in the PRTR storage basin. The design and operation of this scanner is described. A relay circuit fault-finding system was placed in operation in the PRTR. Ionization chambers are being fabricated to demonstrate the application of regenerating Pu elements. Design and fabrication work on an in-core ^{11}B neutron flux monitor using solid-sheath coaxial cables is reported. Developmental work on a microwave neutron flux monitor is described. Research on electromagnetic, thermal, and ultrasonic nondestructive testing methods is reported. Eddy current and ultrasonic applications in fatigue and residual stress detection were investigated. Efforts in a USAEC/AECL program on nondestructive testing of fuel sheaths are also reported. (J.R.D.)

22661 (KFK-275) EIN FLEXIBLES ELEKTRONISCHES BAUSTEINSYSTEM ZUR DATENERFASSUNG BEI KERNPHYSIKALISCHEN EXPERIMENTEN. (A Versatile System of Electronic Subrack Modules for Data Gathering in Nuclear Physics Experiments). R. Hartenstein and W. Juengst (Kernforschungszentrum, Karlsruhe (West Germany). Institut fur Experimentelle Kernphysik). Dec. 1964. 108p. Dep.(mn).

A versatile system of electronic subrack modules and cabinets for collecting nuclear data offered in digital form is described. The available parts of the system are ESONE-type plug-in units and cabinets. The system includes scalers, timers, cabinets for those plug-in-units and electronic control units for scanning and punching or printing out the information. (auth)

22662 (LA-3201) AN ANALYSIS OF THE ABERRATIONS OF AN ASYMMETRICAL CZERNY-TURNER SPECTROGRAPH. Prince E. Rouse, Jr. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Nov. 1964. Contract W-7405-eng-36. 52p. Dep.; $3.00(cy), 2(mn) CFSTI.

Geometrical optics was used in a study of the aberrations of an asymmetrical Czerny-Turner plane-grating spectrograph. Conditions were found for obtaining a straight focal curve that does not change with rotation of the grating. The astigmatism and coma of a 5-meter instrument operating at about f/40 were calculated; the coma can be made negligible by proper choice of the lateral position of the entrance slit. (auth)

22663 (LADC-6436) AN AUTOMATIC RECORDING MULTIGRADIENT CAPILLARY VISCOMETER. J. H. Larkins, J. D. Perrings, G. R. Shepherd, and B. J. Noland (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1964]. Contract [W-7405-eng-36]. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

An automatic recording multigradient capillary viscometer was designed and constructed. Using miniature incandescent lamps and photodiodes, the device utilizes the change in refractive and reflective characteristics of the meniscus as it passes the light beam to actuate timers which record liquid column interval flow times. The operational simplicity and inherent precision of the system and its relative absence of operator timing errors recommend its use in laboratories that perform routine viscosity determinations. (auth)

22664 (ORNL-P-1070) INFLUENCE OF CO–CO_2 ENVIRONMENTS ON THE CALIBRATION OF CHROMEL-P-ALUMEL THERMOCOUPLES. H. E. McCoy, Jr. (Oak Ridge National Lab., Tenn.). 1965. Contract W-7405-eng-26. 18p. (CONF-650204-4). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Meeting on Thermocouple Technology and the Effects of Nuclear Radiation on Thermocouples, Washington, D. C.

Observations are reported of the behavior of Chromel-P–Alumel thermocouples in CO, CO_2–5% CO, and CO_2 environments. Emf drift determinations, carbon analyses, and metallographic examinations were carried out on the exposed specimens. The results indicate that the thermocouple output decreases with exposure at high temperatures, and that the changes are greater than in air. The mechanism of the changes is probably removal of Cr from solution by oxidation in CO_2-rich mixtures, and carburization and oxidation in CO-rich mixtures. (D.L.C.)

22665 (WERL-1114-1) INVESTIGATION OF CORROSION FILMS ON INCONEL AND AISI TYPE 304 STAINLESS STEEL BY TWO NEW TOOLS: THE SPINNING-SOURCE MASS SPECTROGRAPH MICROPROBE AND THE SCANNING ELECTRON MICROSCOPE. W. M. Hickam, G. G. Sweeney, and W. T. Lindsay, Jr. (Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.). Jan. 1965. Contract AT(11-1)-Gen-14. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The results of a preliminary study on the use of the spinning-source mass spectrograph microprobe and the scanning electron microscope to investigate surfaces of Inconel and AISI type 304 stainless steel corroded in high temperature water are reported. The results showed that the scanning electron microscope has great potential usefulness for the study of corrosion reactions. This results in part from the unusual contrast-producing process, which can reveal surface features not easily distinguished by other means, and in part from the fact that the examination is nondestructive and does not require surface replication. The spinning-source mass spectrograph microprobe in its present state of development is less suited to sampling very thin (<1μ) oxide films than to thin layers of unoxidized metal. (P.C.H.)

22666 A SPECTROSCOPE FOR OBSERVING ELECTRON PARAMAGNETIC RESONANCE AT TEMPERATURES BELOW 1°K. V. B. Fedorov (Inst. of Physics, Academy of Sciences, USSR). Cryogenics, 5: 12-16(Feb. 1965).

A spectroscope used in a previous experiment to study the phase transition from paramagnetism to antiferromagnetism in a molecular crystal of the stable free radical α-α diphenyl β-picryl hydrazyl is described. The constructional features of the apparatus is considered, and the possibility of measuring spin-lattice relaxation times at low temperatures is discussed. (L.B.S.)

22667 HIGH-SENSITIVITY d.c. AMPLIFIER WITH SUPERCONDUCTING MODULATOR. V. N. Kachinskii (Moscow State Univ.). Cryogenics, 5: 34-6(Feb. 1965).

A direct current amplifier is described in which the signal is modulated by a superconducting modulator, working at helium temperatures. The sensitivity of the amplifier is 10^{-10}V for an input impedance of 10^{-4} ohm. (auth)

22668 THE NSEC PHOTO-PULSES. K. Takamastu. Genshikaku Kenkyu, 8: 114-21(1963). (In Japanese)

The characteristics of several photopulses were investigated for the purpose of adjusting and calibrating photomultipliers and particle detectors, by means of a hydrogen gas discharge tube, a mercury switch, and a lead switch with metallic dry surface. It is pointed out that the photopulse wave-form obtained with the mercury relay switch is better than that of the lead switch, but has a lower repeat frequency (100 c). A hydrogen gas discharge tube (up to 10 kc) is desirable for pulses of higher repeat frequency. (L.B.S.)

22669 EMERGENCY AIR SAMPLER. D. H. Stoddard (E. I. du Pont de Nemours & Co., Aiken, S. C.). Health Phys., 11: 320(Apr. 1965). (TID-20909)

A portable air sampler is described that was designed for emergency use. The sampler operates from its own power supply and draws air at a rate of about 6 ft^3/min through a 3-in.-diameter disc of Gelman Type-E fiberglass paper mounted ahead of a charcoal filter and can operate alternatively as an annular impactor sampler. (C.H.)

22670 THEORY OF SPIN GENERATORS. R. M. Umarkhodzhaev. Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1207-10(1964). (In Russian)

The inertial nonlinearity of a spin generator with a linear amplifier in the feedback circuit is considered; the system of equations for the self-oscillating system is written, and the stationary frequency and amplitude are derived. The effects of the parameters of the radio circuit on the frequency and amplitude of the generator with inertial nonlinearity are studied. The stationary frequencies of spin generators with given block diagrams are calculated. The use of the frequency delay of a spin generator for following the magnitude of the magnetic field is discussed. (M.J.T.)

22671 A SELF-OSCILLATING ELECTRON GUN. Chusuke Munakata and Hiroshi Watanabe (Hitachi Ltd., Tokyo). J. Electronmicroscopy (Tokyo), 13: 19-22(Nov. 1964).

A blocking oscillator is constructed with a tri-electrode electron gun to get a pulsed beam. The period of the pulsed beam obtained is from the order of msec to sec. The pulse width is from a few msec to a few times ten msec. The characteristics of the pulse transformer are essential for obtaining the better rise time response as well as the larger pulse width. (auth)

22672 STATISTICAL APPLICATIONS OF CERTAIN PHOTOMULTIPLIERS (56 AVP AND XP 1020). Robert Evrard and Claude Gazier (Universite de Paris, Orsay, France). J. Phys. (Paris), 26: 37A-48A(Jan. 1965). (In French)

In this study of statistical properties of photomultiplier tubes, fluctuations of the output signal are analyzed in connexion with fluctuations of elementary processes, such as secondary emission, electron collection, etc... It is thus possible to estimate the importance of each noise source. In addition this analysis provides some information on the secondary emission distribution law. The gain was first measured, and the losses between the first dynodes were estimated. The pulse-height distribution for single photoelectron pulses was investigated; for primary energy in excess of 130 ev the experimental variance is larger than the variance calculated in the case of a Poisson emission.

For photons of high energy (>4 ev), a second peak was observed in the distribution curves, corresponding approximatively to a gain twice as large as the normal one; it is thus possible that some emission of electrons pairs should occur. The total collection efficiency for various incident light conditions was also measured. When the photocathode is entirely illuminated, this parameter is between 60 and 75% for the five photomultipliers analyzed. The results were applied to the study of resolution in gamma spectroscopy; the fluctuations of the scintillator and the average number of useful photons for one incident gamma are estimated. (auth)

22673 TRANSISTORIZED D.C. CONVERTERS FOR THE HIGH VOLTAGES SUPPLY OF RADIATION DETECTORS. R. Alle and G. Boucke (Telefunken AG, Ulm, Ger.). Kerntechnik, 7: 65-70(Feb. 1965). (In German)

The design of d-c converters for a wide output voltage range and a strongly variable load is essentially affected by the stray capacities of the transformer and the rectifiers. It seems that it is not possible to build converters which only by variation of the conducting time cover the desired voltage and load range. It is, however, possible to realize converters having constant conduction time and being controlled by variation of the repetition rate. The disadvantage of this converter type is the high ripple of the output voltage. This disadvantage can be eliminated by a transistor connected in series with the high-voltage circuit. A converter which is controlled by variation of the supply voltage implies the smallest restrictions on the stray capacities. This type of converter offers, however, only a minor efficiency at lower output voltages because a part of the battery voltage is wasted in a series resistor. Care must be taken to adapt the base current of the switching transistor to the varying load conditions. (auth)

22674 MATRICES IN ION OPTICS AND THEIR APPLICATION TO MASS SPECTROSCOPY. Isao Takeshita. Natl. Tech. Rept., 9: 99-110(1963).

A four-dimensional transfer matrix is introduced as a convenient method for describing ion optics in the first order approximation. The vector space of this transfer matrix consists of position, angle, energy deviation, and mass deviation. The properties of such matrices are discussed and the matrix elements are analytically determined without solving the equation of motion except three integral constants. The over-all transfer matrix of complex mass spectrograph is calculated by the matrix manipulation of the transfer matrices of various parts of the system. The multi-stage magnet system may increase the resolving power for the direction focusing instrument. In the case of a double focusing instrument, the resolving power is not improved by increasing the number of magnetic field but by increasing the number of electrostatic field without enlarging its dimension. An example is presented and compared with the usual double focusing mass spectrograph. The equation of motion is solved and three integral constants are determined for the case of the electrostatic and magnetic field of axial symmetry. (auth)

22675 GENERATOR OF 500-KV NANOSECOND PULSES. G. A. Vorob'ev and N. S. Rudenko (Tomsk Polytechnic Inst., USSR). Pribory i Tekhn. Eksperim., No. 1, 109-11(Jan.-Feb. 1965). (In Russian)

A 500-kv pulse generator with 1.5-nsec front was described. The generator consists of storage capacity in which glycerine of a dielectric character is used, charge chamber for compression, and transmitting line. The storage capacity is charged by a multistage pulse generator. Because the coaxial construction of the storage capacity–transmission line system was eliminated, the dimensions of the charge circuit were reduced and steep pulse fronts were obtained. (tr-auth)

22676 POWER SOURCE STABILIZED AT ±250 KV. Yu. A. Karzhavin, Yu. V. Kulikov, N. I. Malashkevich, D. V. Rakitskii, and V. N. Ramzhin (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 1, 120-3(Jan.-Feb. 1965). (In Russian)

A high voltage (±250-kv) source is described; the stability of the source is ±0.1% and the power output is 6 kw. The formation of the high voltage is produced by two stages: the first stage is the UZG-10M (commercial ultrasonic assembly with some alterations) with consecutive resonance circuit at guaranteed output at 70 kv effective voltage; the second stage is a cascade generator with a cascade number $n = 3$. (tr-auth)

22677 GENERATOR OF NANOSECOND LIGHT PULSES. K. A. Gazaryan, V. S. Pantuev, and M. N. Khachaturyan (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 1, 161-3(Jan.-Feb. 1965). (In Russian)

A generator of light pulses of 2 to 10 nsec duration is based on discharge corona tubes with voltage pulses and lengths in the presence of amplitudes ~1 kv being neglected. The generator of ignition pulses has 12 simultaneous outputs on a coaxial cable. (tr-auth)

22678 NUCLEAR PRECESSION MAGNETOMETER WITH COMBINED POLARIZATION AND MEASUREMENT PROCESSES. A. I. Filatov, A. P. Stepanov, and V. M. Stotskii (Ural Polytechnic Inst., USSR). Pribory i Tekhn. Eksperim., No. 1, 169-74(Jan.-Feb. 1965). (In Russian)

The method of the measurement of the earth's magnetic field based on the appearance of free nuclear precession in the presence of the continuous dynamic polarization of the protons of aqueous solutions of potassium nitrodisulfonate was investigated. The precession of nuclear magnetization was begun after the reversal of the latter at the angle $\pi/2$ with respect to the measured field that was done with short pulses of auxiliary magnetic fields. The experimental results of the investigation on the laboratory model that gives two readings per second were reported. (tr-auth)

22679 NUCLEAR MAGNETOMETER FOR MEASURING INHOMOGENEOUS MAGNETIC FIELDS. D. P. Vasilevskaya, L. V. Vlasov, and Yu. N. Denisov (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 1, 174-7(Jan.-Feb. 1965). (In Russian)

The nuclear magnetometer, used for precision measurements of magnetic fields with gradients from 1000 to 3500 oersted/cm, was described. The results of the calculation of fields of two types of electric quadrupoles, forming compensating gradients in the area of ampoules with "active material," were reported. (tr-auth)

22680 ION SOURCE MASS-SPECTROMETER FOR MEASURING SIMULTANEOUSLY THREE SOLID PHASE SPECIMENS. G. M. Mirianashvili, M. Sh. Kaviladze, and I. V. Abashidze. Pribory i Tekhn. Eksperim., No. 1, 215-16(Jan.-Feb. 1965). (In Russian)

Descriptions are given of the design and performance of a rigidly fixed tungsten or nickel ion source used for measuring simultaneously three solid specimens. The three tantalum or nickel evaporation films were distributed at 120° to each other. The measurements of the ratio of $^{39}K/^{41}K$ isotopes in the same specimen coated on all three bands showed a mean difference not exceeding 0.2 to 0.4%. (R.V.J.)

22681 TEMPERATURE TRANSDUCER FOR THERMOGRAVIMETRIC STUDIES. J. G. Schnizlein, John Brewer, and D. F. Fischer (Argonne National Lab., Ill.). Rev. Sci. Instr., 36: 591-3(May 1965).

An instrument was designed to measure the temperature of a sample suspended in a thermobalance without interfering with the balance operation. Continuous and simultaneous temperature and weight records therefore can be obtained. The instrument uses the principle of a magnetic amplifier to sense a current caused by the potential generated by a thermocouple in the sample. A d-c potential linear with temperature is recorded. Precision was demonstrated to be better than 2°C up to 700°C. No measurable effect of the temperature transducer on weight recorded by the analytical balance was detected. Buoyancy and convection effects on weight are discussed. (auth)

22682 OPTICAL MEASUREMENT OF SWITCH JITTER. G. K. Oertel and M. D. Williams (Langley Research Center, Hampton, Va.). Rev. Sci. Instr., 36: 672-3(May 1965).

An optical method is described for simultaneous monitoring of more than 100 luminous events on a single film record (the breakdown of spark gaps). A time resolution better than 1 nsec may be achieved. The system employs light pipes, an image converter streak camera, and a trigger delay generator, all commercially available items. Sample records of the breakdown of a sample of 16 spark gaps in a megajoule capacitor bank are shown; the time resolution is about 1 nsec. (auth)

22683 AN IMPROVED INTEGRATING CIRCUIT. Jens Rasmussen and Kristian Soe/Hojbjerg (to Atomenergikommissionen). British Patent 981,149. Jan. 29, 1965. Priority date May 5, 1960, Denmark.

An integrating circuit is patented by use of which rescaling may be performed either manually without previous calculation in each case or automatically. An auxiliary capacitor is included in the circuit, which may be connected alternatively either between the input of the amplifier and a point on a voltage divider connected between the output of the amplifier and earth, or as a member of a circuit designed to change the charge of the auxiliary capacitor, whereby the voltage output of the amplifier may be changed by a given factor. Switches are used to change the auxiliary connections manually, or relays adapted to be operated automatically when the output voltage of the integrating circuit reaches predetermined values may be used. (A.G.W.)

Radiation Detection

Refer also to abstracts 22118, 22291, 22363, 22589, 22641, 23340, 23613, 23991, and 24181.

22684 (AE-174) IMPROVEMENTS IN APPLIED GAMMA-RAY SPECTROMETRY WITH GERMANIUM SEMICONDUCTOR DETECTOR. D. Brune, J. Dubois, and S. Hellstroem (Aktiebolaget Atomenergi, Stockholm (Sweden)). Jan. 1965. 17p. Dep.(mn).

A germanium semiconductor detector is used in four cases of applied gamma spectrometry. In one case the weak activity contribution of ^{134}Cs in ^{137}Cs standard sources has been determined. The second case concerns the determination of ^{42}K in samples of biological origin containing strong ^{24}Na activities. In the third case the ^{94}Nb and ^{95}Nb activities from neutron-irradiated niobium foils used in the dosimetry of high neutron fluxes with long exposure times have been completely resolved, and it has been possible to determine the ratio of the two activities with a high degree of accuracy. Finally, a $^{95}Zr-^{95}Nb$ source has been analyzed in a similar way with respect to its radiochemical composition. The resolution obtained also made possible a determination of the branching ratio of the two gamma transitions in ^{95}Zr and of the energies of the gamma transitions of both nuclides. (auth)

22685 (ANL-6839(p.12-17)) MULTIPLE-CRYSTAL-POSITION TECHNIQUE FOR WHOLE-BODY MEASUREMENTS. C. E. Miller (Argonne National Lab., Ill.).

A single-crystal, multiple-position whole-body γ counter was developed to detect substantial nonuniformity in the distribution of ^{226}Ra in man. The patient is placed on an unpadded lucite slab centered lengthwise under the crystal track. A large uncollimated NaI(Tl) crystal is suspended with the face of the crystal 30 cm above the surface of the slab. The patient's γ-ray spectra are recorded with the crystal placed in turn at 7 equally-spaced positions along the patient's longitudinal axis. The count rates obtained from the 7 measurements and from measurements in a phantom are used in equations that are solved with the aid of an electronic computer. (C.H.)

22686 (CEA-R-2405) RÉALISATION D'UN NOUVEAU CONVERTISSEUR TEMPS-AMPLITUDE À DIODES "TUNNEL" AMÉLIORANT LA SPECTROMÉTRIE DES NEUTRONS RAPIDES PAR TEMPS-DE-VOL. (Development of a New Time-Amplitude Converter with Tunnel Diodes for Improving Time-of-Flight Fast Neutron Spectrometry). R. Van Zurk (Commissariat à l'Énergie Atomique, Grenoble (France). Centre d'Études Nucléaires). 1964. 41p. Dep.(mn).

Thesis submitted to Grenoble Univ. (France).

A time-amplitude convertor with Esaki diodes, the events being preselected before analysis, allows the design of fast-neutron time-of-flight spectrometer with a 1.5×10^{-9} sec overall time resolution for $^{12}C(n,n')$ at 14 Mev. (auth)

22687 (CEA-R-2739) CONTROLE DE LA CONTAMINATION DE L'AIR PAR LE PLUTONIUM DANS LES LABORATOIRES. (Monitoring of Atmospheric Contamination by Plutonium in Laboratories). Joseph Pomarola, André Risselin, and Pierre Feliers (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre de Études Nucléaires). Feb. 1965. 32p. Dep.(mn).

The importance of the immediate detection of Pu contamination in the atmosphere is discussed. Design features are described for a Pu monitor that employs a coincidence counter capable of discrimination between the α activity due to Pu on filter paper and that from the decay products of radon and thoron. An alarm sounds when a fixed amount of activity from Pu is reached. The Pu monitor gave good performance in initial tests. The important problems involved in Pu monitoring are discussed and the experiments and results are described. (C.H.)

22688 (CONF-640607(Vol.I)(Paper C-4)) NEUTRON FLUX MONITORS AND THERMOCOUPLES FOR IN-CORE MEASUREMENTS. R. C. Hawkings (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 30p. (CRL-85)

The development and status of the following types of in-core neutron-flux-monitoring devices is reviewed: flow-type (activation) monitors; neutron-sensitive ion chambers; solid-state detectors; neutron thermopiles; thermocouple detectors (neutron thermometers); and beta-current neutron detectors. (T.F.H.)

22689 (CONF-640607(Vol.I)(Paper A-6)) SOME STUDIES FOR IN CORE REACTOR MEASUREMENTS. J. Duchene and J. Furet (Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucléaires). 15p.

Descriptions are given of: the development of fission chambers and associated circuits for in-core neutron flux measurement, such as flux-distribution absolute calibration or start-up; and the development of γ radiation detectors, such as the calorimeter type or the ionization-chamber type. (auth)

22690 (EUR-2247.e) TEST EQUIPMENT FOR ACCURATE DETERMINATION OF TIME RELATIONS AND ITS USE FOR THE MEASUREMENT OF THE TIMING ACCURACY AND THE CALIBRATION OF FAST PHOTOMULTIPLIERS. H. Meyer and H. Verelst (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center and European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). 1965. 35p. Dep.(mn).

Test equipment for time calibration of fast photomultipliers used for measurements in the nanosecond region is described. Silicon pn junctions are used as pulsed light sources for simulation of detected radiation. The general problem of detection of time information out of photomultiplier pulses is studied. For this purpose a fast precise discriminator and two "zero crossing" circuits, different in their detailed function, were realized. When measured with electronic exponentially shaped pulses, both zero crossing circuits give a residual time uncertainty, smaller $\pm$ 0.1 nsec for pulse amplitudes between 0.5 and 5 v and pulse rise times up to 20 nsec. For photomultiplier pulses from light pulses of constant amplitude, a timing accuracy smaller than 0.1 nsec with the discriminator and of 0.2 with the two zero crossing circuits was reached. For the worse results with zero crossing circuits for time information

detection, the fact that this type of circuit is more sensitive against background influences and residual pulse shape jitter, must be responsible. A fast coincidence unit and a time/height converter were used for time measurement. As an example of their application, the measurement of the transit time spread of two photomultipliers (56 AVP and RCA 7265) vs. the location of the light at the photocathode is described (the used pn junctions are practically point sources). (auth)

22691 (GA-5418) CAP—A COLLIMATOR ANALYSIS PROGRAM. Henry C. Honeck (General Atomic, San Diego, Calif.). July 16, 1964. Contract AT(04-3)-167. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The Collimator Analysis Program, CAP, is a FORTRAN program designed to compute the fraction of particles that pass through a collimator system, which is a measure of the efficiency, and provide information as to which collimators are limiting the beam. The source, collimators, and detector may be of either rectangular or circular shape with arbitrary alignment. The efficiency is computed for each point on the source and is integrated to provide the average efficiency for the source. (auth)

22692 (HASL-150) SPECTROMETRIC TECHNIQUES FOR MEASURING ENVIRONMENTAL GAMMA RADIATION. Harold L. Beck, William J. Condon, and Wayne M. Lowder (New York Operations Office. Health and Safety Lab., New York Operations Office (AEC), N. Y.). Oct. 1964. 77p. Dep.; $3.00(cy), 2(mn) CFSTI.

Pulse height spectra obtained in the field using a large NaI(Tl) crystal can be analyzed by relatively unsophisticated methods to determine accurately total environmental γ dose rates, as well as the individual dose rate contributions, from ^{40}K, the ^{238}U series, the ^{232}Th series, and the principal γ-emitting fission products. The calibration of a 5-in. by 3-in. detector is described in detail, and the applicability and limitations of the spectral analysis methods are examined. Several problems associated with field measurements are discussed, in particular the effects of radon migration from the soil, soil moisture, and natural fallout. Evidence is presented to demonstrate the validity and utility of dosimetric and related information obtained from field spectra analyzed by these methods. (auth)

22693 (HW-84481) A MONITOR FOR RADIOIODINE IN REACTOR COOLING WATER. H. G. Reick (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 5, 1964. Contract AT(45-1)-1350. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A system was developed for monitoring radioiodine in reactor cooling water. Carbon tetrachloride is used to extract the iodine isotopes from the effluent sample stream. A gamma detector is used to measure gross gamma activity in the carbon tetrachloride. The feasibility of the system was demonstrated. The ^{131}I concentration in the effluent during normal reactor operating conditions is a reasonably constant fraction of the total iodine. Increased iodine activity was observed during rupture conditions. (auth)

22694 (IEA-76) NEUTRON VELOCITY SELECTOR OF THE INSTITUTO DE ENERGIA ATOMICA MECHANICAL DESIGN AND ELECTRONIC CONTROL. Raul Brenner and R. L. Zimmerman (Instituto de Energia Atômica, São Paulo (Brazil)). Dec. 1964. 13p. (CONF-631104-4). Dep.(mn).

From the Meeting on the Utilization of Research Reactors, São Paulo, Brazil.

A Fermi-type neutron velocity selector was constructed to eliminate higher order reflections in a crystal monochromator and for experiments where high intensity beams of very slow neutrons are required. The rotor has been designed to select very slow neutrons, although with poor resolution, in an effort to obtain an intense beam. Provisions were made to reduce neutron and gamma background. The mechanical design is described and some considerations about the bearings design are added. The automatic speed control system is described, and consists of a 5-hp d-c motor powered by a controlled three-phase thyratron rectifier. The short term stability is about 0.5% after warm-up. For start-up, a constant current of operation is featured. (auth)

22695 (IEA-83) MEASUREMENT OF FAST NEUTRON FLUXES AND SPECTRA AT THE I.E.A. 5 Mw REACTOR. S. B. Herdade, A. A. Suarez, O. Y. Mafra, D. C. da Cunha Reis, and L. P. de Moura (Instituto de Energia Atômica, São Paulo (Brazil)). Dec. 1964. 22p. (CONF-631104-6). Dep.(mn).

From the Meeting on the Utilization of Research Reactors, São Paulo, Brazil.

Fast neutron fluxes and energy distribution were measured in some irradiation facilities at the IEA 5-Mw swimming pool reactor. The differential fast neutron spectrum in the energy interval 0.5 to 10 Mev was determined in beam hole number 7, utilizing a simplified proton recoil telescope and nuclear emulsion techniques. Threshold detector techniques are being used to specify fast neutron spectra inside the reactor. Magnesium sulfate is suggested as a "double" threshold detector, through the reactions $^{32}S(n,p)\ ^{32}P(E_{eff}$ = 2.9 Mev) and $^{24}Mg(n,p)^{24}Na(E_{eff}$ = 6.3 Mev), providing a simple and low cost way to measure fast fluxes and estimate the shape of the integral fast neutron spectrum. Some preliminary results are presented. (auth)

22696 (IKF-D-32) EIN T-D-GASTARGET MIT KOINZIDENZEINRICHTUNG. (A T-D Gas Target With Coincidence Arrangement). Otto Meyer (Frankfurt Univ. (West Germany). Institut fur Kernphysik). 1961. 44p. Dep.(mn).

The reaction $T(d,n)^4He$ was used for the production of monoenergetic neutrons in the range around 14 Mev. A target chamber with coincidence arrangment was constructed therefore; with the help of a transfer apparatus, the chamber can be filled as desired with gaseous tritium. The counting of the ^4He particles makes possible the absolute determination of the neutron flux; by supplementary counting of the coincidences between the ^4He particles and the pulses released in various neutron counters, the efficiency of this neutron detector could be determined. The efficiency measured for two plastic scintillators agrees within the limits of error with the calculated efficiency. (tr-auth)

22697 (JUL-213-ST) KUGELTECHNIKEN ZUR MESSUNG VON FLUSSDICHTE UND DESISLEISTUNGEN THERMISCHER, INTERMEDIÄRER UND SCHNELLER NEUTRONEN. (Sphere Techniques for the Measurement of Flux Density and Dose Rate of Thermal, Intermediate, and Fast Neutrons). D. Nachtigall and F. Rohloff (Kernforschungsanlage, Jülich (West Germany). Zentralabteilung Strahlenschutz). Nov. 1964. 51p. Dep.(mn).

From the viewpoint of radiation protection, it is important to know the flux density, energy dose rate, and dose rate equivalent in a neutron field. Its measurement in the energy range from 10^{-2} to 10^7 ev has been a problem up to the present. The Bramblett, Ewing, and Bonner Neutron scintillation counter with LiI(Eu) crystal and polyethylene spheres is useful for this purpose. With the help of a three-sphere combination (2, 3½, and 11" diameter) and by summing up the count rates taken with the three spheres, neutron flux densities in the energy range from 0.5 up to 7×10^6 ev can be measured in all directions and independent of the neutron energy. A two-sphere technique (2¼ and 11¾" diameter) with weight factors approximates the neutron energy dose curve in the range from 10^{-2} to 7×10^6 ev. Another three-sphere combination (5, 7, and 12" diameter) and weight factors give a measurement of the neutron dose rate equivalent in the range from 0.5 to 7×10^6 ev. A biological dose curve, using quality factors, can also be approximated between 10^{-2} and 7×10^6 ev by the three-sphere combination (2, 4, and 7" diameter) and weight factors. Later changes of the weight factors can be considered by approximations with other sphere combinations. In order to obtain the four quantities named, nine different measurements with the help of nine different sphere diameters are necessary. The procedure, however, can be optimized. With the help of five measurements with five different

sphere diameters (2, 3½, and 11½") and weight factors, the same four quantities in the range from 10^{-2} to 10^{7} ev and the average energy can be obtained. In addition to LiI (Eu) crystals, all detectors operating with the $^{6}Li(n,\alpha)$ reaction are practicable, especially LiF thermoluminescent detectors. (tr-auth)

22698 (TID-21547) DEVELOPMENT OF A HIGH-SENSITIVITY FAST NEUTRON DOSIMETER. Quarterly Report No. 7, November 1, 1964–January 31, 1965. B. H. Chase, R. R. F. Speers, J. M. Swartz, and M. O. Thurston (Phylatron Corp., Columbus, Ohio). Contract AT(11-1)-1226. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A model of the high-sensitivity readout system was constructed during the period and diode processing studies were continued. Construction of an exposure chamber for the Pu–Be source is in progress. (J.R.D.)

22699 (UCRL-11296) GEOMETRY CORRECTION FACTORS FOR PROTON-RECOIL TRACK SAMPLES TAKEN FROM NUCLEAR EMULSIONS. Richard L. Lehman and J. R. Wayland, Jr. (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 14, 1964. Contract W-7405-eng-48. 17p.

Geometry correction factors for proton-recoil track samples taken from nuclear emulsions have been derived. The factors apply to samples of tracks that have been selected at random from the emulsion volume, and to tracks created under conditions of s-wave scattering with fast neutrons. The derived factors are found as functions of track length, emulsion thickness, and angle of scattering. (auth)

22700 (UCRL-11946) MOUNTINGS AND HOUSINGS FOR LITHIUM-DRIFTED SILICON AND GERMANIUM DETECTORS. C. Eugene Miner (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 24, 1965. Contract W-7405-eng-48. 41p. Dep.; $2.00(cy), 1(mn) CFSTI.

A versatile cooling and housing design and several methods for mounting lithium-drifted silicon and germanium detectors are described. Since considerable care must be exercised to keep non-encapsulated germanium detectors in their best operating condition, greater emphasis is placed on mountings for germanium detectors than on mountings for silicon detectors. Developmental problems, materials, and methods of evacuating the housings are discussed in detail. (auth)

22701 (UCRL-12245) LITHIUM-DRIFTED GERMANIUM DETECTORS FOR HIGH-RESOLUTION BETA- AND GAMMA-RAY SPECTROSCOPY. D. C. Camp and G. A. Armantrout (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 30, 1965. Contract W-7405-eng-48. 31p. (CONF-650507-2). Dep.(mn); $2.00 (cy), 1(mn) CFSTI.

From IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna.

Two types of germanium detectors have been fabricated using the lithium-ion drift technique. Those of the first type have active volumes in excess of 6 cm^3 and are primarily intended for high-energy (>1.0 Mev) γ spectroscopy. Those of the second type are large area, low capacity, windowless detectors intended for very-high-resolution β and low-energy γ spectroscopy. Both types are operated in a vacuum at liquid nitrogen temperature (77°K). The large volume detectors have areas greater than 6 cm^2 with depletion depths in excess of 1 cm. The experimental resolution (FWHM) obtainable with these detectors is limited at low energies by the noise level of the preamplifier, while at high energies (>1 Mev) the limitation is due to amplifier instability. Typical resolutions are 3, 6, and 12 kev for 0.122, 1.333, and 5.0 Mev γ rays, respectively, while the photopeak efficiency ranges from approximately 75% at 122 kev to 1% at 1.333 Mev and 0.5% at 5 Mev. At 5 Mev the pair-peak efficiency is ~5%. Typical low capacity detectors are slices (less than 5 mm thick) from the large volume detectors and have an area of 3 cm by 1 cm (the depletion depth). This gives a reduction in detector capacitance, which results in a significant improvement in the resolution compared to that obtained with the large volume detectors for a given preamplifier. At 0.122 and 1.333 Mev, resolutions of 1.9 and 4.1 kev respectively have been observed. Since these are essentially windowless detectors they make excellent small β spectrometers. A detailed evaluation of the properties and various applications of these two types of germanium detectors is discussed. (auth)

22702 (UCRL-12272) RADIOACTIVE EFFLUENT MONITORING AT THE NEVADA TEST SITE FOLLOWING NUCLEAR DETONATIONS. R. L. Gotchy (Lawrence Radiation Lab., Univ. of California, Livermore). Dec. 21, 1964. Contract W-7405-eng-48. 28p. Dep.; $2.00(cy), 1(mn) CFSTI.

Highly successful methods were developed for the containment and monitoring of radioactive inert gases during postnuclear-detonation drilling and sampling operations. By use of improved blow-out-preventers and rotating heads controlled and reduced to a minimum the releases of radioactive inert gases. Any releases which might occur are monitored instantaneously and accurately. It is believed the methods developed for monitoring these releases are novel if not unique, and with suitable modifications could be used to monitor gaseous releases from reactors and chemical separations plants. Since such a monitoring facility had to be able to be moved from place to place within minutes after notification, it was designed to fit in a trailer. The radiation monitoring trailer discussed is a modified radar trailer containing instrumentation for measuring any radioactive gases, notably ^{133}Xe, ^{133m}Xe, and ^{135}Xe, released through the vent-line system. It employs two independent systems for monitoring vent-line effluent releases. The first of these uses a low-range ($0.1–10^{5}$ mR/hr) Jordan argon-filled ionization chamber which monitors dose rates resulting from effluents passing through the vent line to the atmosphere. The second employs a more sophisticated scintillation system which monitors a fraction of the total effluent, and records count rate as well as providing an automatic, sequenced printout of integrated counts on a digital recorder. This instrumentation has the capability of sounding an alarm to the drilling supervisor when a preset release rate through the vent line occurs. It also has a recording air velocity transducer system capable of recording vent-line flow rates up to 2000 linear feet/minute, a sequential charcoal filter air sampler, a recording combustible gas analyzer, and can serve as an automatic single-channel pulse-height analyzer for qualitative analyses of vent-line effluents. In addition, temperature and pressure measuring and recording devices have been added to monitor the BOP during drill-back. (C.H.)

22703 (USNRDL-TR-805) RADIOLOGICAL SEARCH INSTRUMENTATION, TRIESTE I. E. J. Wesley and R. L. Hopton (Naval Radiological Defense Lab., San Francisco, Calif.). Jan. 6, 1965. 24p.

A gross counting system for measuring radioactivity in the ocean, consisting of a log-rate-meter, recorder, and NaI(Tl) scintillation detector, has been developed and installed on Trieste I for operation to a maximum depth of 16,000 feet. All pulses from the detector equivalent to 45-kev gamma rays or more energy are counted. Statistical fluctuation in the background counting rate from normal sea water and detector assembly components limit the sensivity. With an integrating time constant of 3.5 sec and using 3×10^{-11} curie-liter^{-1} as the gamma activity in sea water (^{40}K), the minimum detectable increase in activity for 1.47-Mev gamma rays is 1.36×10^{-11} curie-liter^{-1}. A permanent record of the counting rate, which can indicate two decades above this limit, is obtained on the strip chart recorder. (auth)

22704 NORMALIZATION OF CLINICAL GAMMA RADIATION EXPOSURE MEASUREMENTS IN SWEDEN. R. Thoraeus (Karolinska Institutet, Stockholm). Acta Radiol., Therapy, Phys., Biol. (N.S.), 3: 24-32(Feb. 1965).

An increasing number of dosemeters for radiotherapy in Sweden need calibration for gamma radiation. The most practical way to bring this about has been to construct a

reliable condenser chamber dosemeter, easily transportable and sturdy enough to be sent to the radiotherapy clinics as a reference instrument. The instrument now available for this purpose is described. (auth)

22705 CISCO— A WHOLE-BODY COUNTER FOR DOMESTIC ANIMALS AND MAN. A. R. Twardock, J. R. Georgi, and C. L. Comar (Cornell Univ., Ithaca, N. Y.). Am. J. Vet. Res., 25: 270-3(Jan. 1964).

A description is given of the construction of a large-volume, two-pi liquid scintillation counter (Cisco, or Cornell Inverted Scintillation Counter). The steel room, as shielding for the detector, is of notched joint construction with 5-in. thick steel plates. Its interior dimensions are 5 ft 8 in. wide, 6 ft high, and 6 ft 10 in. long. The entire assembly weighs about 35 tons and rests on a 12-in. thick concrete pad. The detector tank is positioned horizontally with the opening of the well facing downward. This inversion of the detector is useful for counting unanesthetized pigs, sheep, or goats. Six 16-in. photomultiplier tubes mounted directly in contact with the scintillation fluid provide 18% photocathode coverage. Two complete electronic systems are used alternatively. One is an all-vacuum tube system consisting of 2 pulse height analyzers, a double scaler, preamplifier, amplifier, and high-voltage power supply. The other is a transistorized system with a single analyzer and scaler. The 6 photomultiplier tubes on the detector tank are connected in parallel. Energy calibration of the counter was based on the ^{60}Co and ^{40}K γ-ray peaks, assuming a single Compton scattering interaction by each photon passing through the tank. The differential background spectrum for Cisco from 20 kev to 7 Mev is shown. The energy spectrums for ^{137}Cs and ^{40}K obtained from a ^{137}Cs point source and a 25-lb carton of KCl are shown. The resolutions were 60% for the ^{137}Cs peak and 35% for the ^{40}K peak. Two phantoms were prepared, each containing a known amount of KCl and ^{137}Cs mixed with sugar. The sugar mixtures were divided into 4-lb lots and placed in plastic bags and cardboard boxes which were counted in increasing weights and lengths designed to simulate human beings weighing from 60 to 200 lb. Results of these calibrations and equations derived from them are shown. The results showed that the counter is about 2% less efficient for ^{137}Cs than for ^{40}K, but efficiencies for each radionuclide decreased at the same rate per lb of body weight. (BBB)

22706 COMBINED ELECTROSTATIC-MAGNETIC β-SPECTROMETER WITH HIGH LUMINOSITY. PART I: PRINCIPLES AND BASIC PROPERTIES. Karl-Erik Bergkvist. Arkiv Fysik, 27: 383-437(1965).

A new type of high-luminosity β spectrometer, based on a combination of electrostatic and magnetic components, is introduced and studied with respect to some inherent properties. The main imaging properties are assumed to be given by the magnetic component formed by a $\pi\sqrt{2}$-magnetic field with $\alpha_2 = 3/8$. The electrostatic components form corrections on the magnetic imaging and consist of a special source arrangement and an aperture defect corrector. The source is assumed to be in the form of a number of narrow equipotential strips with the potentials varying with the radial position. In front of the source either a fine grid, or suitable electrodes, defines the region of ground potential, and from here the electrons are accelerated within a short distance by an amount depending on their starting point. The potential distribution on the source is chosen so that a difference in starting point is accompanied by a momentum change that the dispersion of the instrument cancels the variation in the radial position of the image point caused by the variation in starting point. Therefore every point on the extended source is imaged on the narrow detector slit. The electrostatic aperture defect corrector is positioned half way between the source and the detector and reduces the aberration for a point source. Electrostatic fields are formed between curved grids with direction and magnitude such that the induced deflections of the orbits neutralize the aperture defect. The possible luminosity will be ultimately limited by third-order aberrations caused by cross terms between source size and aperture size parameters. An example of a practical application of the methods is included. A schematic drawing of the combined system is shown. (auth)

22707 COMBINED ELECTROSTATIC-MAGNETIC β-SPECTROMETER WITH HIGH LUMINOSITY. PART II: APPLICATION OF THE METHODS TO AN $r_0 = 50$ cm IRON YOKE DOUBLE FOCUSING SPECTROMETER. Karl-Erik Bergkvist. Arkiv Fysik, 27: 439-82(1965).

The realization of a combined electrostatic-magnetic β spectrometer with high luminosity, according to principles introduced previously, is described. The system is based on an $r_0 = 50$ cm $\pi\sqrt{2}$ magnetic spectrometer combined with electrostatic components reducing both the aperture defect and the influence of the source width on the resolution. The reduction of the aperture defect is achieved by means of a corrector placed intermediately between the source and the detector and containing electric fields of such magnitude and direction that the electron orbits are deflected so that the radial aberration is considerably reduced. The design and construction of the corrector are described. The influence of the source width on the resolution is reduced by applying an electric potential distribution on the source surface so that the induced energy changes of the electrons, by means of the dispersion in the magnetic field, just compensate for the variation in starting position over the source surface and make all orbits of given nominal momentum pass through the narrow detector slit. A source arrangement suitable for this method is described, as well as techniques used for preparing source backings and for applying the active deposit. The detector slit arrangement providing for adjustments is described. The focusing and measuring procedures are outlined, and examples of the performance given. An increase in luminosity by about a factor of 100 in comparison with the ordinary magnetic $\pi\sqrt{2}$ spectrometer is demonstrated. (auth)

22708 AN AUTOMATICALLY OPERATING DOUBLE FOCUSSING BETA-RAY SPECTROMETER. H. Pettersson, Y. Grunditz, G. Baeckstroem, O. Bergman, S. Antman, and E. Aasa (Uppsala Univ.). Arkiv Fysik, 29: 61-7(1965).

The automatic operation of a double focusing beta spectrometer is described. Spectra are taken automatically by measuring the counting rate for momentum values which are increased by preset constant intervals. The magnetometer system used permits a sensitivity of 5–10 parts in 10^6. A specially constructed current supply is discussed. The proportionality of electron momentum value to voltage divider setting is shown. A new detector slit system was constructed and the detector system was improved. (auth)

22709 THE INVESTIGATION OF THE BETA SENSITIVITY OF A SURFACE-BARRIER SEMICONDUCTOR DETECTOR. Dezsoe Varga. At. Kozlemen., 6: 143-9 (Dec. 1964). (In Hungarian)

The qualities of a surface barrier detector made of silicon and having the resistivity of 300 Ωcm, were investigated from the point of view of electron detection. The relative detection efficiency in the energy range 0–300 kev was determined. (auth)

22710 THE CHARACTERISTICS OF A SPECIAL PERMANENT MAGNETIC BETA RAY SPECTROGRAPH SET. Ferenc Illes and Denes Berenyi. At. Kozlemen., 6: 157-61(Dec. 1964). (In Hungarian)

The main constructional data of a permanent magnetic beta ray spectrograph set consisting of two units are presented. An experimental method to determine the magnetic characteristics of the spectrographs is described. The magnetic and energy characteristics are given. (auth)

22711 CARE AND MAINTENANCE OF NUCLEAR INSTRUMENTS. PART 3. Carl L. Henry. Atomics, [18:] 26-9(Mar.-Apr. 1965).

The operation, care, and maintenance of an environmental monitor, a scintillation type detector alarm system, an alarm system that uses G-M tubes, a medical scanner, and a gamma spectrometer analyzer are discussed. (C.E.S.)

22712 CONSTRUCTION AND PROPERTIES OF A LARGE-AREA SCINTILLATION COUNTER. P. Sahlmann

and J. Truemper (Universitat, Kiel). Atomkernenergie, 10: 41-3(Jan.-Feb. 1965). (In German)

A large area (1-m^2) xylene scintillation counter consisting of a glass tank was constructed, and its properties were investigated. The pulse-height distribution due to cosmic radiation obtained by a 5-in. photomultiplier has a half-width of 80%. The response of the counter decreases by 15% towards the corners as compared to the value at the center. The temperature coefficient was measured to be 0.2%/°C. (auth)

22713 TESTING OF MEASUREMENT FILMS WITH LOW ENERGY-DEPENDENCE FOR PERSONAL-DOSE MONITORING. P. Midecke and H. J. Bross (Staatliche Materialprufungsamtes NW, Dortmund-Aplerbeck, Ger.). Atompraxis, 11: 84-8(Feb. 1965). (In German)

Tests showed that photographic emulsions containing p-terphenyl can be used for personal-dose monitoring. At present, no definite improvement in evaluational accuracy can be attained by using this film material. For this purpose, it would be necessary to do away with the remaining energy dependence by changing the composition of the emulsions. Then would it be possible to develop an energy-independent evaluational procedure. One property of sensitive terphenyl film, in comparison with ordinary film, is of significance in personal dosimetry: there is no fading of the latent picture during the critical time interval of about 40 days. This eliminates one possibility of obtaining erroneous dose values. (auth)

22714 EXPERIENCE WITH PHOSPHATE GLASS DOSIMETERS IN PERSONNEL DOSIMETRY. H. Kiefer, R. Maushart, and E. Piesch (Kernforschungszentrums, Karlsruhe, Ger.). Atompraxis, 11: 88-93(Feb. 1965). (In German)

The energy dependence, direction sensitivity, and dose rate dependence of dose indication of simple dosimeter arrangements used in practical dose measurements at the Karlsruhe Nuclear Research Center are discussed. Silver-activated metaphosphate glasses are used as the dosimeters. Results showed that phosphate glasses in connection with a suitable type of capsule, for quantum energies above 35 kev, are superior to film dosimeters in Germany in reliability, simplicity, and accuracy of recording the measured values. (auth)

22715 RESULTS OF THE EVALUATION OF CONTROL FILMS IRRADIATED FOR THE PLOTTING STATION IN ERLANGEN BY THE PTB FROM 1961 TO 1964. F. Wachsmann and G. Drexler (Universitat, Erlangen-Nurnberg, Ger.). Atompraxis, 11: 93-5(Feb. 1965). (In German)

As shown by 230 control evaluations of film dosimeters the maximum and medium margin of error of the evaluation, as allowed by the standard sheet for film dosimeter DIN 6816, is not exceeded. (auth)

22716 BF_3 COUNTERS. CONVENTIONAL FISSION CHAMBERS. SEMI-CONDUCTOR-FISSION CHAMBERS. J.-L. Campan, J. Duchene, J.-P. Gourdon, and R. Schuttler (Centre d'Etudes Nucleaires, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 82, 1-7(Apr. 1964). (In French) (EUR-2136.f)

The essential characteristics of ionization detectors for the measurement of in-pile neutrons available in industry or produced in the CEA laboratories are summarized together with the trends of detectors now being investigated. (auth)

22717 P-I-N DIODES PINPOINT GAMMA RADIATION. Can. Chem. Process., 49: 77-82(Feb. 1965).

A specially-treated semiconductor promises to provide the key to better neutron activation analysis. Lithium-drifted germanium p-i-n diodes developed for gamma spectroscopy allow intrinsic efficiencies of 0.1 to 1.0% with resolutions that can be 10 times better than the sodium iodide spectrometer. (F.S.A.)

22718 NUCLEAR INSTRUMENTATION MAKES TRIPLE PLAY. H. McIntyre, D. R. Popoff, and C. Arthur Law. Can. Controls Instr., 4: 32-40(Jan.-Feb. 1965).

Descriptions of developments in nuclear instrumentation are presented. Industrial radioisotope performance, failsafe controls for irradiation plants, and semiconductor diodes for gamma detection are discussed. (F.S.A.)

22719 THE EFFICIENCY OF SPARK CHAMBERS. Bernard Marquie, Jacques Maurel, and Daniel Blanc (Faculte des Science, Toulouse). Compt. Rend., 260: 121-4 (Jan. 4, 1965). (In French)

The expressions of efficiency given by Bacon and Nash were modified. With the aid of a spark chamber detecting cosmic radiation, it was verified that the formulas proposed take good account of the curves connecting the efficiency to the delay of the release of the high voltage pulse. (tr-auth)

22720 SPECTROMETER WITH COMPENSATION FOR THE MAGNETIC ANALYSIS OF HIGH ENERGY PARTICLES. Jean-Claude Bizot, Jean Buon, Jacques Lefrancois, Jean Perez y Jorba, and Philippe Roy (Ecole Normale Superieure, Orsay, France). Compt. Rend., 260: 1617-20 (Feb. 8, 1965). (In French)

The principle of a magnetic spectrometer where a compensation of the kinematics is realized and makes possible the use of a large angular opening was established. The spectrometer was developed and its properties were verified by the floating wire method, and then by the detection of high energy particles. (tr-auth)

22721 WINDOWLESS DETECTOR FOR SOFT X-RAY. T. Sasaki. Genshikaku Kenkyu, 8: 131-5(1963). (In Japanese).

A resistance strip type of detector for the soft x-ray range (2-1000Å), which is used mainly for detecting particles from synchrotrons, is described. The outstanding features of the device are presented. (L.B.S.)

22722 STUDIES OF THE COUNTERMEASURES IN ATOMIC ENERGY. MEASUREMENTS OF COLLIMATED RADIATIONS, USING GM-TUBES AND SCINTILLATION COUNTERS, AND THE DISTRIBUTION OF THE COUNTING EFFICIENCIES OF THESE COUNTERS. Jiro Yuhara (Japan Defence Agency). Giho [Res. Develop. Center, Japan Defense Agency], 3: No. 17, 77-94(May 1964). (In Japanese)

A survey on methods and equipment for measuring radiations is presented. The measurement of collimated beta particles and gamma photons, particularly as tests of G-M and scintillation counters, is emphasized. (NSA of Japan)

22723 IMPROVED FLUOROGLASS DOSIMETER AS PERSONNEL MONITORING DOSIMETER AND MICRODOSIMETER. Ryosuke Yokota and Saburo Nakajima (Tokyo Shibaura Electric Co., Ltd.). Health Phys., 11: 241-53 (Apr. 1965).

Low predose and low-Z silver-activated phosphate glass was studied. With due regard to measurement errors, a newly-contrived optical system was employed. This system is insensitive to dirt on glass and its holder, and limits the predose fluorescence due to the holder to a value lower than 8 per cent of that in the prototype. The mechanical accuracy of positioning of the glass is improved. The null detecting method is utilized for the sake of accuracy and sensitivity. Filters for x and gamma rays were studied and badge cases and finger ring cases for x and gamma rays and thermal neutrons was developed. Reproducibility and sensitivity were considerably elevated. The 8 × 8 × 4.7 mm glass has an accuracy of ±15 per cent for 10 mR, ±6 per cent for 25 mR and ±2 per cent for 50 mR of gamma rays. The newly devised holder for fluorods (1 mm ϕ × 6 mm) eliminates errors due to uncertainties of positioning and dirt on glass, and the standard deviation for 500 R becomes 1.4 per cent. A gold sheath shielding case for fluorods is described. A method of dose assessment of x rays and co-existing x and gamma rays and a very simple method of photon dose assessment from 40 kev to 1.25 Mev are described. The fading of this glass is reported. This improved dosimeter is discussed compared with film

dosimetry and as a microdosimeter compared with other microdosimeters. (auth)

22724 STABILIZATION OF DARK-CURRENT DRIFT IN A PHOTOTUBE USED IN A LITHIUM FLUORIDE DOSIMETRY SYSTEM. H. Wade Patterson, Francis M. Miller, and Lowell Kleppe (Univ. of California, Berkeley). Health Phys., 11: 314(Apr. 1965). (UCRL-11666)

Nitrogen gas was used successfully to stabilize the dark-current drift of the PM tube in a lithium fluoride thermoluminescent dosimetry readout apparatus. (C.H.)

22725 DENSITY PERMANENCE OF PROCESSED MONITORING FILMS. A. Bierman and Y. Feige (Soreq Research Establishment, Yavne, Israel). Health Phys., 11: 320-1(Apr. 1965).

The density of processed photographic film radiation dosimeters was measured after storage for 6 years. The same densitometer used for the original reading was employed. The densities of the films had not changed perceptibly in 6 years. (C.H.)

22726 A MINIATURE WARNING DOSIMETER. A. R. Jones (Atomic Energy of Canada Ltd., Chalk River, Ont.). Health Phys., 11: 363-7(May 1965).

A warning dosimeter that is small enough to fit inside a pocket is described. The dosimeter provides an audible alarm when a predetermined exposure to γ rays has occurred. This level is 0.2 R in a low range version and 0.6 R in a high range one. In addition, an audible indication of exposure rate is given. The performance of the instrument is described and limitations on its application are discussed. Brief operating instructions are included. (auth)

22727 CAUSES OF ERRORS IN SOFT X-RAY DOSAGES. P. Van Caneghem, G. Mattelaer, A. Dunjic, and M. L. Beaumariage (Universite, Liege and Universite, Louvain, Belg.). J. Belge Radiol., 47: 825-35(1964). (In French)

Sources of error are discussed which occur easily in dose measurements of soft x ray: filtration by the walls of the chamber, overcharging of the ionisation chamber, absorption by the air, lack of proportionality between the output and the milliamperage, radiation coming from the localizer. Some ways of tracing these errors are described. (tr-auth)

22728 READER FOR MEASUREMENT OF THE DISCHARGE OF CONDENSER ION CHAMBERS. J. Allewaert (Universite, Ghent). J. Belge Radiol., 47: 840-3(1964). (In French)

An electronic electrometer is described for measurement of the discharge of condenser ionization chambers. (tr-auth)

22729 DOSAGE TECHNIQUES FOR BETATRON RADIATIONS AND TELECURIE THERAPY APPARATUS. J. Allewaert (Universite, Ghent). J. Belge Radiol., 47: 906-10(1964). (In French)

Procedures are described for measuring radiation doses from betatron x-ray beams and γ beams from a ^{60}Co teletherapy unit. The techniques are based on the use of ionization chambers and a dose integrator. Tables were prepared for use in the calculation of isodose curves. (C.H.)

22730 STUDY OF A RECOIL PROTON SPECTROMETER. Eric Fort and Pierre Thouvenin (Commissariat a l'Energie Atomique, Paris). J. Phys. (Paris), 26: 7A-10A(Jan. 1965). (In French)

A recoil proton telescope for neutron spectroscopy in the energy range from 3 to 14 Mev is described. Protons recoiling through a $\Delta E/\Delta x$ solid-state detector are stopped in a second-solid state detector. The sum of the pulses produced by a proton in the two detectors is analyzed in a multichannel analyzer. The results are similar to those obtained elsewhere. The use of solid-state detectors for neutron spectroscopy is thus justified. (auth)

22731 HODOSCOPE WITH 120° THIRTY-CHANNEL ANALYZER AT THE 155-Mev SYNCHROCYCLOTRON OF THE FACULTE DES SCIENCES D'ORSAY AND ITS VARIOUS READING APPARATUS. P. Antoine, F. Reide, and G. Verroust (Universite de Paris, Orsay, France). J. Phys. (Paris), 26: 31A-4A(Jan. 1965). (In French)

After a review of the purpose of the analyzer which is attached to the proton synchrocyclotron at Orsay and the advantages of an associated hodoscope, a 30-channel multidetector with its amplifiers; a device for remote readout of 30 scalers; and a device making possible the use of the multidetector with a conventional pulse-height analyser are described. Several experiments performed with this equipment are described. (auth)

22732 STATISTICAL ERRORS IN RADIOACTIVITY MEASUREMENTS AND THEIR GRAPHICAL DETERMINATION. K. Haberer (Technische Hochschule, Karlsruhe, Ger.). Kerntechnik, 7: 49-59(Feb. 1965). (In German)

The reliability of radioactivity measurements in the low-level range is characterized by the size of the statistical counting error which depends on the size of the measured effect, the background counting-rate, and the duration of measurement. Graphical methods can be used for advancing a rapid estimation or determination of this error. Furthermore, from the nomograms and diagrams presented, which are adjusted to various types of preselection such as measuring-time or pulse-count preselection, the influences of various parameters can be conveniently taken, and comparisons can be made of errors and measuring times for various types of preselection. (auth)

22733 NEW METHODS AND APPLICATIONS OF GAMMA SPECTROSCOPY. P. Weinzierl (Osterreichische Studiengesellschaft fur Atomenergie, Seibersdorf, Austria). Kerntechnik, 7: 60-5(Feb. 1965). (In German)

The values for resolution and efficiency are compiled for the following groups of gamma spectrometers: diffraction spectrometer, secondary electron spectrometer using magnetic energy analysis, and secondary electron spectrometer using energy conversion. The excellent properties of these semiconductor detector spectrometers are discussed in detail. Especially, results and application of a Compton and a pair spectrometer using these detectors are described. (auth)

22734 PULSE HEIGHT DISTRIBUTIONS OF PLASTIC SCINTILLATORS FOR GAMMA RADIATION. A. Wensel (Johann-Wolfgang-Goethe-Universitat, Frankfurt am Main). Kerntechnik, 7: 70-4(Feb. 1965). (In German)

Electron energy distributions in plastic scintillators were calculated for various gamma energies using the Monte Carlo method including multiple scattering. Calculations were made with a FORTRAN II program (MESIS) with an IBM 704 computer. Gaussian broadening was calculated with a second program (ISEA). The dependence of various parameters characteristic of the pulse-height distribution on spectral resolution was studied. The shape of the pulse-height distribution depends strongly on scintillator size. (auth)

22735 TWO PULSE GENERATORS FOR TESTING RADIATION DETECTION INSTRUMENTS. T. Friese (Hahn-Meitner-Institut fur Kernforschung, Berlin). Kerntechnik, 7: 75-7(Feb. 1965). (In German)

Two portable pulse generators for testing and calibrating radiation detection instruments are described. The first one (main-line-powered) has 12 calibrated frequencies between 5 Hz and 3 kHz and an amplitude range from ±1 mv to ±10 v. The second, a battery-powered generator with built-in charger, has a frequency range from 5 Hz to 60 kHz and an amplitude range from ±1 mv to ±5 v. (auth)

22736 THE AUTOMATIC SAMPLE-CHANGER WITH THREE MEASURING POSITIONS FOR THE START-UP EXPERIMENTS OF THE REACTOR FRJ-2 (DIDO). K. Beyerle and H. Friedewold (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 78-7(Feb. 1965). (In German)

A sample changer is described, which moves samples successively through three scanners. The samples are

round metal planchets or foils, inserted in open plastic sample holders. The sample holders slide down by gravity through an inclined and curved rail. Along the way, they are arrested in the scanning positions by electromagnetically actuated stoppers. This moving principle allows a very efficient arrangement of shielding masses around detectors and samples. Cross influence of samples in scanning position is averted by the different angular position of the sample channels through the shielding masses and a corresponding zigzag shape of the sample rail. (auth)

22737 IN-PILE COMPONENTS FOR THE CURVED-CRYSTAL GAMMA SPECTROMETER AT THE DR-3 REACTOR AT RISO. O. W. B. Schult, U. Gruber, and B. P. Maier (Technische Hochschule, Munich and Atomenergiekomission, Riso, Roskilde, Denmark). Kerntechnik, 7: 101-4(Mar. 1965). (In German).

The in-pile components for the set-up to measure neutron-capture gamma rays with the Risø curved crystal spectrometer are described, along with a source changer. The advantage of evacuating the liner is discussed. The whole arrangement proved to be very effective and permits the measurement of a partial cross section as low as 2 mb. (auth)

22738 DEADTIME CORRECTION. PART 2. E. G. Andresen (Staatliche Ingenieurschule Gauss, Berlin). Kerntechnik, 7: 126-9(Mar. 1965). (In German).

Methods of measuring dead times for counters are described. Calculations for making deadtime corrections are presented. Effects of operating conditions of the counter were found to be very important. (M.C.G.)

22739 TRANSISTORIZED ELECTROMETRIC AMPLIFIER FOR MEASURING WEAK CURRENTS FROM CHARGED-PARTICLE DETECTORS. N. N. Goryunov, B. I. Savin, and E. N. Sosnovets. Kosmich. Issled., 3: 172-4(Jan.-Feb. 1965). (In Russian)

A transistorized amplifier for measuring weak currents ($< 10^{-7}$ amp) is described, in which the conversion of d-c into voltage pulses proportional in amplitude to the current is realized by means of a capacitor and a relay. The device permits digital registration of the measured current and by virtue of its compact size is a useful component in space probes. Since it is virtually insensitive to the polarity of the measured current, it can be used with either electron or positive-ion detectors. The circuit contains four amplification stages and a nonlinear negative feedback circuit which increases the gain by a factor of 10. For registering widely varying current, several individual amplifiers can be used. Three of the amplifiers were used to measure weak current in the charged-particle collectors of the electrostatic analyzers aboard Cosmos-12 and Cosmos-15. The total dynamic range of the circuit was 1000; the maximum number of pulses in a sequence was 40. Threshold sensitivity of the first amplifier was 10 mv. Threshold current was roughly 8×10^{-15} amp; intensity was 6×10^6 $1/E_0$ part/cm^2/sec/kev (where E_0 is the particle energy in kev to which the analyzer is adjusted). (ATD)

22740 FILM SCANNER AND ITS APPLICATION FOR ISODOSE PLOTTING AND ISODOSE SYNTHESIS. Masaomi Takizawa (Shinshu Univ. Hospital, Matsumoto, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 510-17(Aug. 1964). (In Japanese)

Use of x-ray films to measure the dose of radiation or its attentuation through materials is discussed. On account of its nonlinear characteristics, the film method is only of auxiliary value. An improved x-ray film scanner was developed. It is provided with a logarithmic amplifier for correction of the nonlinear characteristics of x-ray films; further corrections are made by a level discriminating device which sends pulse signals to the scanner. The isodensity curve obtained from the film, which corresponds to isodose curve, is plotted as dotted lines or as colored lines. A monochromatic dot scan is adequate for simple dose distribution situations but the color scan is better to delineate more complicated distributions. Isodose synthesis from two or more isodose curves is easily done by means of logarithmic amplification. This x-ray film scanner was found to be a useful device not only in dosimetry studies but also for quantitative analysis in x-ray diagnosis. Isodose patterns for various radiotherapy techniques using ^{60}Co are illustrated. (BBB)

22741 COLLIMATION OF ALPHA PARTICLES IN AN IONIZATION CHAMBER. R. Benoit, G. Bertolini, and G. B. Restelli (EURATOM, Ispra, Italy). Nucl. Instr. Methods, 29: 149-56(1964). (EUR-2142.e)

Different types of mechanical and electronic collimation of alpha particles in a grid ionization chamber are compared. A new method of electronic collimation independent of the alpha energy is proposed. (auth)

22742 APPLICATIONS OF GERMANIUM GAMMA-RAY DETECTORS. David A. Shirley (Univ. of California, Berkeley). Nucleonics, 23: No. 3, 62-6(Mar. 1965). (UCRL-11865)

The performance of lithium-drifted germanium detectors in gamma spectrometry is discussed in relation to that of NaI(Tl) devices, showing the superior resolution and speed of the former. Applications of germanium detectors to gamma spectrum analysis; coincidence and angular-correlation measurements; Mössbauer spectroscopy; and studies of nuclear orientation, conversion coefficients, neutron-capture gamma rays, and meson (μ) x rays are then considered. (D.C.W.)

22743 ABSOLUTE LIQUID-SCINTILLATION COUNTING OF BETA EMITTERS. Gerald Goldstein (Oak Ridge National Lab., Tenn.). Nucleonics, 23: No. 3, 67-9(Mar. 1965). (ORNL-P-800)

An extrapolation technique for absolute counting of beta emitters in a liquid scintillator was investigated using a Packard Model 314 Liquid Scintillation Spectrometer. Counting efficiencies of 100% were obtained for beta groups above 200 kev with a relative deviation of ~1%. Quenching agents were found to have virtually no effects for beta groups above 200 kev, and no interference from gamma emission was observed. When two beta groups were present, the total of both could be determined. (D.C.W.)

22744 GAMMA SCANNING FOR BURNUP. W. R. Diggle and W. H. Blackadder (Dounreay Experimental Reactor Establishment, Thurso, Scotland, U. K.). Nucleonics, 23: No. 3, 71-4; 96(Mar. 1965). (TRG-Report-603)

The gamma scanning of fuel elements to determine burnup is discussed, including the requirements on the radioisotope, the experimental assembly and technique, and calibration of the assembly. (D.C.W.)

22745 He^3-SPECTROMETER CHARACTERISTICS AND APPLICATIONS. Armin W. Manning, Thomas B. Jeter, Howard Schuckler, and Wayne Slack (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Nucleonics, 23: No. 4, 69-71(Apr. 1965).

The characteristics of a ^{3}He sandwich-type silicon surface barrier detector were studied. The dependence of spectrometer resolution and efficiency of helium pressure is determined and the results are summarized. The spectrometer was used for measuring the neutron attenuation in paraffin. (L.B.S.)

22746 MULTICHANNEL ANALYZER APPLICATIONS. Nucleus (Chicago), No. 17, 6p.(Jan. 1965).

The use of a multichannel pulse-height analyzer to improve the signal-to-noise ratio of spectrometric records from weak emissions is described. A particular wavelength region of the spectrum is scanned repeatedly with a rapid-scanning spectrometer, and the spectrometer output is recorded in a multichannel analyzer. The counts from successive scans are summed; and the digital information is transferred to magnetic tape. An investigation of the resonance scattering of sunlight from N_2^+ in the upper atmosphere is considered as an example of computer use in the spectral analysis. (D.C.W.)

22747 DIGITAL COMPUTERS IN NUCLEAR RADIATION COUNTING. Nucleus (Chicago), No. 19, 1-11(Mar. 1965).

The counting problems that can be solved by computers are outlined, and the programming of computers to perform these operations is briefly discussed. (D.C.W.)

22748 SPARK CHAMBERS IN MAGNETIC FIELD. M. I. Daion, V. M. Knyazev, and G. A. Marikyan (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 1, 54-9(Jan.-Feb. 1965). (In Russian)

Experimental data on the magnitude of the displacement of the spark in magnetic fields ($E \times H$ effect) in chambers, filled with mixtures of air + Ar + alcohol vapor, were reported for wide intervals of size, magnetic fields, purifying electric fields, and delay of high-voltage pulses. The calculation and the character of the $E \times H$ effect in similar chambers and in chambers filled with inert gases were given. (tr-auth)

22749 A CHAMBER WITH FINE ELECTRODES AND THE POSITION OF SPARK RECTIFYING POINT. F. Legar, V. I. Nikanorov, G. Peter, and A. F. Pisarev (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 1, 59-64(Jan.-Feb. 1965). (In Russian)

The technology of the production of electrodes from foils with a bilateral active surface for spark chambers was studied, and some characteristics of spark chambers with fine electrodes were reported. The change of the distance from the negative electrode to the spark rectification point was investigated in dependence on the particle energy and the angle of its passage through the chamber. It was shown that with an increase of the initial density of the ionization gas in the chamber, the Townsend coefficient α increases at the expense of interacting charges of individual avalanches. (tr-auth)

22750 CHARACTERISTICS OF DISCHARGE CHAMBERS FILLED WITH NEON AND OTHER ADMIXTURES. I. I. Gromov, V. I. Nikanorov, G. Peter, and A. F. Pisarev (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 1, 64-8(Jan.-Feb. 1965). (In Russian)

The results of the investigation of the parameters of discharge chambers with interelectrode clearance of 7 cm and fillings with neon with admixtures of Ar, H_2O, C_2H_5OH, CH_4, and CCl_4 were reported. It was shown that the introduction into the chamber of CH_4 in amounts of 1% decreased the memory time from 16 to 1 μsec, but the use of 3×10^{-6} CCl_4 reduced it from 16 to 1.6 μsec. The admixture of H_2O and C_2H_5OH did not improve the time characteristics of the chamber. (tr-auth)

22751 A DEVICE FOR STUDYING WIDE ATMOSPHERIC SHOWERS BY MEANS OF SCINTILLATION COUNTERS. G. B. Khristiansen, A. T. Abrosimov, G. V. Bogoslovskii, V. I. Boitsov, and K. I. Solov'ev. Pribory i Tekhn. Eksperim., No. 1, 69-76(Jan.-Feb. 1965). (In Russian)

Scintillation counter apparatus was described. The detector assembly consists of 20 scintillators with a total area of 10 m^2; plastic scintillators in a polystyrene base (1% PPP + 0.04% POPOP) were used in the form of square plates with the dimensions of $707 \times 707 \times 65$ mm^2. The scintillation counters and electronic assembly makes it possible to register in a wide range both the current densities and the relative times of arrival of particles of wide atmospheric showers of cosmic radiation. The diagrams of the preamplifier, the amplifier, the control system established, the plan for time measurement with pulse delays in the mμsec range, and the registration circuits were described. The characteristics of the apparatus and data on the results of controlled experiments were reported. (tr-auth)

22752 CALORIMETER FOR MEASURING BREMSSTRAHLUNG FLUX. N. G. Afanas'ev, N. G. Shevchenko, and G. N. Afanas'ev (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Pribory i Tekhn. Eksperim., No. 1, 82-5(Jan.-Feb. 1965). (In Russian)

The device for calorimetric measurement of the bremsstrahlung flux, based on the compensation method, was described. The increase of temperature caused by the passage of γ quanta through the absorber, was registered. By means of artificial preheating of the compensating cylinders the equilibrium scheme of the a-c current maintains the temperature equality of the absorbing and compensating cylinders with a precision of 5×10^{-4}°C. In the presence of bremsstrahlung flux of 10^9 effective quanta/sec (400 Mev), the error in the determination of the temperature does not exceed 3%. In the presence of higher fluxes the precision is increased. (tr-auth)

22753 NANOSECOND COINCIDENCE SCHEME FOR TRANSISTORS AND TUNNEL DIODES. I. A. Golutvin and Yu. V. Zanevskii (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 1, 86-9(Jan.-Feb. 1965). (In Russian)

The coincidence circuit for scintillation counters with the use of printed circuits, adaptable to physical experiments with accelerators, was described. The dead time with double pulses is ~10 nsec; this makes possible a coincidence time of ~1.5 nsec. All contacts were completed by direct current. (tr-auth)

22754 WIDE-RANGE DISCRETE TIME-AMPLITUDE CONVERTER. N. N. Goryunov and A. D. Erlykin (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 1, 90-4(Jan.-Feb. 1965). (In Russian)

Investigations were made of the construction of RC circuit in wide range of logarithmic time-to-amplitude pulse converters. A simple system of logarithmic number-amplitude conversions were developed for operations with an ionization chamber. The system has a 2×10^3 dynamic range and does not demand strong stabilization of the amplification coefficient for the amplifier and discrimination threshold. The order of accuracy for pulse amplitude at 3×10^2 range was 10% and not over 20% for amplitudes exceeding the threshold more than 3×10^2 times. (tr-auth)

22755 UNIVERSAL DISTRIBUTION BLOCK OF TWO-DIMENSIONAL ANALYZER. A. N. Sinaev and Kuo-Chen Tsa'o (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 1, 95-9(Jan.-Feb. 1965). (In Russian)

The distribution block of a two-dimensional analyzer, designed for the analysis of pulses according to one or two parameters, was described. The following forms of analysis were possible: single recording of the amplitudes of the spectra of two detectors, amplitude analysis, time-amplitude analysis, amplitude-time analysis, and also the usual amplitude and time analyses. The minimum width of the time channel is 0.2 μsec, the minimum width of the amplitude channel is 0.5 v. The dead time is 1 μsec in the channel. The distribution block is used in combination with a 256-channel block of accumulators with memory stable in the memory tube and is used in experiments performed on the JINR synchrocyclotron. (tr-auth)

22756 STABILIZATION OF SCINTILLATION COUNTER. S. K. Sotnikov, B. V. Efimov, and A. P. Tsitovich (Inst. of Nuclear Energy, USSR). Pribory i Tekhn. Eksperim., No. 1, 100-4(Jan.-Feb. 1965). (In Russian)

The method for the stabilization of scintillation counters was investigated by the method of supporting light pulses. The distinctive characteristic of the method is the utilization in the comparison scheme of electrical pulses, proportional to the intensity of the light flash given. The comparison scheme is controlled by the gain coefficients of the linear amplifier. The introduction of the circuit examined into gamma spectrometers improved the stability of the spectral lines from 3 to 5 to 0.3 to 0.4%. (tr-auth)

22757 PRE-AMPLIFIER OF LARGE-VOLUME SEMICONDUCTOR DETECTORS. A. A. Babushkin and A. K. Mednikov (Joint Inst. of Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 1, 105-8(Jan.-Feb. 1965). (In Russian)

A charge-sensitive preamplifier, designed for work with surface-barrier detectors with effective active surface of ~2 cm^2, was described. (tr-auth)

22758 IMPROVED 4π BETA COUNTER WITH A MINIMUM BACKGROUND. V. V. Emel'yanov (Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 1, 203-4(Jan.-Feb. 1965). (In Russian)

The construction of a 4π proportional counter that makes it possible to measure the activity of samples starting with values of 3 to 4 decays per minute and to exchange quickly without disrupting the operating system of the device, was described. (tr-auth)

22759 DOSIMETRY OF STRONG GAMMA RADIATION FIELDS BY MEANS OF COLORED CELLOPHANE. F. A. Makhlis (Scientific Research Inst. of Rubber Industry, USSR). Pribory i Tekhn. Eksperim., No. 1, 204-5(Jan.-Feb. 1965). (In Russian)

The possibility of using colored cellophane in the qualitative dosimetry of strong gamma ray fields was investigated. It was shown that colored cellophane can be used for dosimetric measurements at doses up to 1.5×10^8 R. The reading of the dosimeter does not depend upon the strength of the dose. (tr-auth)

22760 THE INFLUENCE OF VARIATIONS IN PRESSURE AND TEMPERATURE ON THE CALIBRATION OF A PHOTOELECTRIC NUCLEUS COUNTER. P. J. Nolan and J. A. Scott (University Coll., Dublin). Proc. Roy. Irish Acad., Sect. A, 64: 37-48(Dec. 1964).

It is shown that the mass of water released in an adiabatic expansion in a photoelectric nucleus counter depends on the pressure in the counter. The resulting effect on the size of the cloud droplets and on the reading of the counter is examined. Results in agreement with experiment are obtained. An examination of the influence of temperature variation also gives results in agreement with previous observations. Correction factors for small variations in pressure and temperature of the photoelectric counter are given. (auth)

22761 AN INTEGRATED RECORDING FILM DENSITOMETER AND ISODOSE PLOTTER. Carl R. Bogardus, Jr. (Univ. of Oklahoma, Oklahoma City), William White, and William E. Powers. Radiology, 84: 735-44(Apr. 1965).

Design features are described for an integrated recording film densitometer and isodose plotter for use in calculations of the isodose dose and depth distribution in the x radiation treatment of carcinoma using multiple radiation beams or a radioactive applicator. The instrument consists of an isodose plotter with a photodensitometer and a scintillation probe to be used as alternative methods of measuring dose. Information obtained by the measuring devices is fed through special electronic circuits and is recorded by a modified printout system. The instrument gave good results in clinical trials when checked with small ionization chambers. (C.H.)

22762 THE DETERMINATION OF THE RELATIVE DISPERSION OF THE LATENT IMAGE. M. Nicolae (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 549-57(1964). (In French)

By studying the kinetics of development of the images formed by alpha particles, electrons, and light, it was established that the rate of development varies exponentially with the redox potential of the developer for the initial period of development: $dD/dt = Ce^{KP}$red. This relation was used to establish that the dispersion of the latent image formed by different radiations is determined by the nature of the radiation and the sensitivity of the emulsion. The relative dispersion of images from α and β particles and light in NIKFI R and IFA EN_2 emulsions was compared. (tr-auth)

22763 RESPONSE OF PLASTIC SCINTILLATORS TO COSMIC RAY AIR SHOWERS. A. D. Bray, D. F. Crawford, D. L. Jauncey, et al. (Univ. of Sydney). Rev. Sci. Instr., 36: 587-91(May 1965).

The response of plastic scintillators to the flux of particles occurring in cosmic ray air showers was measured at various distances from the center of showers of various sizes. The number of scintillator particles S obtained by dividing the observed pulse height by the mode of the pulse-height distribution due to single fast muons was compared with the number of incident ionizing particles G seen by Wilson cloud chambers and Geiger counters. The ratio S/G is always greater than unity. It increases with increasing number of charged particles per square meter, being 1.1 for 100 scintillator particles per m^2 and 4.0 for 10,000 scintillator particles per m^2. It varies with radial distance from the shower center and with shower size, being 1.2 on average at 30 m from the center of showers of $\sim 10^5$ particles and greater than 4 near the center of large showers. The increase in S/G is partly due to cascading of the electromagnetic component within the plastic scintillator but mostly to nuclear interactions produced in the scintillator by strongly interacting particles. (auth)

22764 RECYCLING INTEGRATOR FOR MEASURING NANOAMPERE CURRENTS. James H. McQuaid (Univ. of California, Livermore). Rev. Sci. Instr., 36: 599-600(May 1965). (UCRL-12250)

A current-to-frequency converter for gamma Mev measurements is described. In this application, a photomultiplier tube is used as the current source. Currents as low as 10^{-9} amp were measured with a long-term stability of 0.09%/8h period. Extremely low leakage is achieved by the use of a field-effect transistor at the input. The current to be measured is integrated and digitized. The output pulses are then fed to a frequency counter for digital readout. (auth)

22765 DESIGN AND PERFORMANCE OF A HIGH MOMENTUM, HIGH LUMINOSITY SPECTROMETER FOR PARTICLE ANALYSIS. J. V. Allaby and D. M. Ritson (Stanford Univ., Calif.). Rev. Sci. Instr., 36: 607-10(May 1965).

A 90°-bend, n = 0 magnetic spectrometer was constructed which uses curved field boundaries to achieve second-order correction of the focal properties and to make the image plane normal to the emerging particles. The spectrometer has a 112-cm radius of curvature and a maximum momentum capability of 725 Mev/c. The window frame yoke, with sloping edge profiles to minimize edge saturation, enables the focal properties to remain invariant up to 21 kgauss. The solid angle acceptance is 8×10^{-3} sr with 0.1% resolution and the maximum momentum acceptance is ±5%. (auth)

22766 MULTI-CHANNEL DIGITAL PROGRAM GENERATOR FOR SIMULATING CHARGED PARTICLE PENETRATION OF COUNTER TELESCOPES. Richard Weissman (Univ. of Chicago). Rev. Sci. Instr., 36: 683-9(May 1965).

The simulation of charged-particle penetration in solid-state detectors was accomplished, using 2-μsec infrared light pulses. Infrared stimulators were incorporated in the design of cosmic-ray telescopes for space experiments, and a program generator was designed and built to provide programmed groups of stimulus pulses in which various coincidence and anticoincidence combinations can be set up in the detectors with a predetermined choice in each group of amplitude, repetition rate, and number of simulated events. The program generator and infrared pulsing circuits are described with consideration given to the logic design and circuitry employed. Other applications of the program generator are discussed, such as providing serial and parallel binary coded word groups, programmed sets of pulse trains, and/or time delays of fractions of a millisecond up to months in duration, control of or by computer data systems, and general purpose digital system testing. (auth)

22767 THE IMPORTANCE OF CALORIMETRY FOR THE DOSIMETRY OF IONIZING RADIATION. Robert G. Jaeger, Johannes Nagl, and Alexandre Sanielevici. Strahlentherapie, 126: 321-7(Mar. 1965). (In German)

The calorimetric measuring method applicable in a very universal range has been introduced more and more, in recent times, into radiological measuring techniques. A highly automatic microcalorimeter for the absolute evaluation of activity, especially for α- and β-emitters, was

constructed. Besides the calorimetric measurement of the radiation flux density, the dose-calorimetry of photons above 1 Mev and of electrons above 10 Mev is a useful fundamental method for the absolute and direct measurement of the dose. For comparison measurements in different places transportable quasi-adiabatic dose calorimeter was constructed on the basis of the work of Laughlin, Genna and co-workers. With this instrument it is possible to measure 20 rad/min with an accuracy of ±1%. Interesting results were observed especially in measuring depth dose curves of high energy electrons in tissue equivalent material. (tr-auth)

22768 THE RELATIVE DETERMINATION OF THE ABSORBED DOSES IN THE TUMOR AND IN IRRADIATED HEALTHY TISSUES FOR X AND GAMMA RADIATION WITH A CHEMICAL DOSIMETER. Oskar Topol and Josef Benes (Charles Univ., Prague). Strahlentherapie, 126: 328-30 (Mar. 1965). (In German)

A method is described to determine the energy absorbed in a tumor and the surrounding healthy tissue using normal laboratory equipment and commercial chemicals. From this model it might be assumed that equal amounts of energy absorbed in the tumor might result in different biological reactions, if the amount of absorbed energy differs in the surrounding healthy tissue. In the calculations we assume, that the ratio of absorbed energies in tumor and surrounding healthy tissue has an optimal value. Possibilities for the determination of this "optimal" ratio will be discussed in another paper to be published. (tr-auth)

22769 PREAMPLIFIERS FOR SEMICONDUCTOR CHARGED PARTICLE DETECTORS. B. V. Fefilov. Tr. 5-oi Pyatoi Nauchn.-Tekhn. Konf. po Yadern. Radioelektronike, 1961, 39-43(1962). (In Russian)

Specifications for semiconductor charged-particle detectors are discussed. A preamplifier circuit diagram for use with silicon detectors having a surface barrier is presented. The preamplifier input is on a cascade circuit, which ensures minimum noise. The best tubes for the circuit are 6S3P and 6S4P triodes. The signal is further amplified by a twin with 6Zh9P tubes and a large negative feedback. The preamplifier output is coordinated with cable RK-2 by a cathode follower on the 6S3P tube. The preamplifier amplification factor is 500. The output amplitude of the signal is stabilized when the detector bias and capacitance shift by a capacitance feedback through a small capacitor on a so-called charge amplifier. A circuit diagram is also given for a preamplifier for use with semiconductor detectors in a strong magnetic field. The best tubes here are the 6S6B and 6N16B. Because the electrodes are flat, when they are oriented perpendicularly to the lines of force of the magnetic field, the steepness of the anode current does not decrease more than 30% with an increase in the magnetic field from 0 to 12 kgauss. This preamplifier is built on the same circuit as the first. Since the circuit has only a few small parts, the total volume occupied is 50 cc or less. The overall amplification factor is 35. (TTT)

22770 AUTOMATIC MONITORING OF RADIOACTIVE RADIATION BY A TELEMETERING SYSTEM. O. Jaegermalm. Vaisala News, No. 17, 11-13(1963).

A practical method for automatic monitoring of radioactive radiation is described. The main purpose is to detect and measure changes in gamma radiation near the ground surface at several distant observation points, from which the information is automatically transmitted to a monitoring center, where the radiation information is recorded. The center is equipped with alarm signal devices for automatic indication of dangerous increase in radiation. (Public Health Eng. Abstr., 45: (Jan. 1965))

22771 TIME AND MAGNETIC FIELD CONTROLS FOR THE COMPTON SPECTROMETER. Hans-Hermann Cremer (Argonne National Lab., Ill.). Z. Instrumentenk., 72: 186-9(June 1964). (In German)

The timing and magnetic field control system for the Argonne Magnetic Compton Electron Spectrometer is described. (auth)

22772 RADIATSIONNAYA FIZIKA. II. DOSIMETRIYA NEITRONOV I GAMMA-LUCHEI. (Radiation Physics. II. Neutron and Gamma Ray Dosimetry). E. M. Kashlinskii, ed. Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. 115p.

Twelve papers presented at the symposium on neutron and γ-ray dosimetry, held Nov. 27–29, 1963 in Riga, are included. Separate abstracts were prepared for each paper. (R.V.J.)

For abstracts of individual papers see: 21808, 22080, 22773, 22774, 22775, 22776, 22777, 22778, 22779, 22780, 22781, and 24185.

22773 APPLICATION OF ACTIVATION METHOD FOR NEUTRON RECORDING IN IRRADIATION OF BIOLOGICAL OBJECTS. Yu. A. Tatsii (Bogomolets Inst. of Physiology, Academy of Sciences, Ukrainian SSR). p.21-6 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

Experiments with various methods for fast neutron tissue dosimetry indicate that the activation method combined with the threshold detector can be efficiently used for the control of the constant irradiation conditions. The threshold detector is capable of estimating the total amount of radiation absorption and various types of radiation by utilizing tissue equivalent phantoms. (R.V.J.)

22774 USE OF AQUEOUS CARBOHYDRATE SOLUTIONS FOR DOSIMETRY OF γ RAYS AND MIXED GAMMA-NEUTRON FIELDS. S. V. Starodubtsev, V. V. Generalova, and G. V. Polyak (Inst. of Nuclear Physics, Uzbek SSR). p.27-33 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

Radiation stability of various liquid chemicals (carbohydrate solutions and liquid aromatic series hydrocarbons) was investigated in order to determine the mechanism of radiation damage during γ and neutron irradiation. Gamma dosimeters with concentrated glucose and maltose aqueous solutions were used for a rapid determination of energy absorption in the tissue-equivalent systems in a dosage range from 10^5 to 8×10^8 Rad. The optical activity and absorption spectrum analysis showed that glucose and maltose solutions have good radiation stability and exhibit specific advantages in reactor dosimetry by not interfering with the extraction of specimens from the active zone. The measurements of absorption energy in various substances and the introduced assumption on neutron spectra in the irradiation zone permitted the theoretical separation of the total absorbed energy into γ- and n-components and helped to determine the yield according to the optical rotation and absorption spectra for neutrons. Calculations also showed that the radiolysis yield in glucose and maltose solutions does not depend on the type of ionizing radiation and varies only 10 to 15% in transitions from γ rays to fast neutrons. (R.V.J.)

22775 CHEMICAL DOSIMETRY ON IMPROVED NUCLEAR REACTOR IRT-2000. Yu. E. Tilikis, D. K. Tone, and V. Ya. Kal'kis (Inst. of Physics, Academy of Sciences, Latvian SSR). p.35-49 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

The advantages of ferrosulfate dosimetry on the Russian reactor IRT-2000 are described, and practical applications of the system are analyzed. The measuring method developed on the basis of preliminary investigations was carried out with various dosimetric solutions. Solutions containing $FeSO_4 \cdot 7H_2O$, or Mohr's salt were used. (R.V.J.)

22776 MEASUREMENTS OF FAST NEUTRON FLUXES BY MEANS OF THRESHOLD REACTIONS IN EXPERIMENTS INVOLVING IRRADIATION OF MATERIALS IN THE RFT REACTOR. N. F. Pravdyuk, V. P. Ivanov, V. N. Kuznetsov, V. I. Vikhrov, and V. N. Perevezentsev (Kurchatov Inst. of Nuclear Physics, USSR). p.51-64 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

The problems of absolute measurements of integral fast neutron fluxes by means of threshold reactions $^{238}U(n,f)$, $^{31}P(n,p)^{31}S$, $^{32}S(n,p)^{32}P$, $^{58}Ni(n,p)^{58}Co$, $^{35}Cl(n,\alpha)^{32}P$, and $^{27}Al(n,\alpha)^{24}Na$ in the RFT reactor channels were analyzed. The absolute measurements were carried out with a 4π-flow counter, 4π-slit scintillation counter, by β-γ coincidence methods, γ spectrometer, calibrated proportional and crystal counters with layers of fissionable materials. The experimental method is outlined. The use of threshold reactions $^{237}Np(n,f)$ and $^{232}Th(n,f)$ with effective threshold energies of 0.75 and 2.0 Mev, respectively, proved useful in the measurements. (R.V.J.)

22777 MEASUREMENTS OF NEUTRON FLUXES IN IRT-2000 REACTOR. K. K. Baltmugur, D. Ya. Gubatova, and R. Ya. Kemer. p.65-70 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

An activation method was used for measuring thermal and fast neutron fluxes in vertical experimental channels with two types of active zone configurations. The first active zone consisted of 29 fuel elements and 8 graphite blocks and the second of 30 fuel elements and 11 graphite blocks. In both cases the free area between the elements was filled with water. Absolute thermal fluxes were measured using gold foils. The relative fast neutron fluxes were measured using sulfur threshold detectors. The data on distribution of the thermal and fast neutron fluxes along the vertical experimental channels were tabulated. The data obtained for the fast neutron fluxes were not sufficiently accurate. (R.V.J.)

22778 HIGH-SENSITIVITY RADIOMETER OF NEUTRONS AND GAMMA EMISSIONS OF VRNG-2 TYPE. L. S. Druskina, V. I. Krasnenkov, and T. V. Timofeeva (Ioffe Inst. of Physics and Tech., Leningrad). p.79-86 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

An improved small size portable radiometer with a universal feeding and a transducer equipped with neutron and γ-counters capable of alternating measurements of both types of radiation is described. The pulse recording was carried out by an electromechanical recorder with a wide recording range increased by a decade scale system and by an intensimeter. The first recorder was used for measuring weak neutron fluxes and the second for large fluxes. Amplitude pulse distribution from ^{60}Co γ background and neutrons emitted from a Po–Be source were plotted. The radiometer is capable of measuring neutron flux density from 0.03 to 3000 n/cm^2 sec and γ emissions from 0.05 to 1200 μR/sec. (R.V.J.)

22779 PROPORTIONAL COUNTER FOR RECORDING FAST NEUTRONS. V. P. Pasechnik (Bogomolets Inst. of Physiology, Academy of Sciences, Ukrainian SSR). p.87-92 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Uchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

Descriptions are given of a $^{10}BF_3$ proportional counter capable of effective dosimetric measurements at any orientation to the neutron beam. The counter was constructed from a 30 mm in diameter and 250 mm long duralumin tube with a working volume of 175 cm^3 and a tungsten filament. The geometry of (120 mm in diameter and 70 mm thick) hollow paraffin moderator surrounding the counter enabled a constant effective recording of Po–Be source neutrons at various orientations to the axis of the beam. Performance of the detector was compared with methane-filled and ^3He-filled proportional detectors, and the installation for gas purification is described. (R.V.J.)

22780 SUSTAINED UNITY OF MEASUREMENTS IN NEUTRON DOSIMETRY. S. I. Slepyshkov, M. F. Yudin, and A. P. Yanovskii (Mendeleev All-Union Scientific-Research Inst. of Metrology, USSR). p.93-106 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

An assembly of graphite and tissue equivalent (filled with tissue equivalent gas) chambers with a double neutron moderator (consisting of a set of 324 mm long paraffin cylinders enclosed in an aluminum container) was constructed for measuring neutron doses. The order of error of the instrument was ±8 to 10% at neutron energies from 0.3 to 10 Mev and γ background up to 0.3 mR/sec. The double moderating instrument was capable of estimating neutron mean energy in a complex spectrum with the order of error not exceeding ±10 to 20% at energies from 0.1 to 5 Mev and measuring the flux density by a relative method. The method for estimating neutron scattering by walls and air is described. Containers with neutron source collimators were used for calibrating working neutron apparatus for the protection of the personnel. The density of the flux was considerably increased (~70%) and the mean diminished only slightly (~7 to 10%). (R.V.J.)

22781 PROBLEMS IN THE METHODS OF INDIVIDUAL DOSIMETRIC CONTROL OF FAST NEUTRONS USING NUCLEAR EMULSIONS. M. I. Salatskaya, V. N. Lededev, and L. S. Zolin (Joint Inst. of Nuclear Research, Dubna, USSR). p.107-15 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

Data are given on dosimetric techniques and characteristics of photoemulsion packets using K (20 μ) type emulsion coated on (130 to 140 μ) triacetate backing calibrated neutron sources Po + Be and Pu + Be were used for calibrating neutron packets. The chemical treatment of the emulsion and emulsion scanning are described. (R.V.J.)

22782 TRUDY PYATOI NAUCHNO-TEKHNICHESKOI KONFERENTSII PO YADERNOI RADIOELEKTRONIKE, 18-23 DEK. 1961. (Reports of the Fifth Scientific-Technical Conference on Nuclear Radioelectronics, Dec. 18-23, 1961. Vol. I. Pulse Schemes and Instrumentations, Power Supplies and Stabilizers). K. E. Erglis and A. A. Sanin, eds. Moscow, Gosatomizdat, 1962. 246p. (CONF-611201 (Vol. I))

Twenty five papers are included on handling the data from nuclear radiation detectors. Pulse schemes, amplifiers, oscillographs, power supplies, coincidence schemes, pulse volt meters, and methods for generating various signals are discussed. (R.V.J.)

22783 TRUDY PYATOI NAUCHNO-TEKHNICHESKOI KONFERENTSII PO YADERNOI RADIOELEKTRONIKE, 18-23 DEK. 1961. (Reports of the Fifth Scientific-Technical Conference on Nuclear Radioelectronics, Dec. 18-23, 1961. Vol. 2. Multichannel Pulse Analyzers. G. I. Zabiakin, A. A. Markov, A. L. Matalin, and I. V. Shtranikh, eds. Moscow, Gosatomizdat, 1963. 203p. (CONF-611201 (Vol.2)(Pt.I))

Twenty five papers on input-output block analyzer design and performance are presented. High-speed electron converters for continuous multidimensional analysis, time converters, memory devices, commutating installations of 50 to 100 channels are discussed. Analyzers with charge-storage tubes (for the memory installations) and the schemes of various single-channel time-amplitude transistor analyzers are also discussed. (R.V.J.)

22784 TRUDY PYATOI NAUCHNO-TEKHNICHESKOI KONFERENTSII PO YADERNOI RADIOELEKTRONIKE, 18-23 DEK. 1961. (Reports of the Fifth Scientific-Technical Conference on Nuclear Radioelectronics, Dec. 18-23, 1961. Vol. 2. Multichannel Pulse Analyzers. Part II). G. I. Zabiakin, A. A. Markov, A. L. Matalin, and I. V. Shtranikh, eds. Moscow, Gosatomizdat, 1963. 174p. (CONF-611201(Vol.2)(Pt.II))

Thirteen papers on the design and performance of multichannel pulse analyzers, analyzers with ferrite-cone memory, and analyzers with magnetic drums and ribbons, and memory on delay lines are included. (R.V.J.)

22785 TRUDY PYATOI NAUCHNO-TEKHNICHESKOI KONFERENTSII PO YADERNOI RADIOELEKTRONIKE,

18-23 DEK. 1961. (Reports of the Fifth Scientific-Technical Conference on Nuclear Radioelectronics, Dec. 18-23, 1961. Vol. 3. Radiation Detectors). V. K. Voitovetskii, ed. Moscow, Gosatomizdat, 1963. 144p. (CONF-611201 (Vol.3))

Nineteen papers on radiation detectors are included. Spark chambers for particle track recordings, scintillation and semiconductor neutron detectors, and ionization detectors for fission particles are discussed. Neutron and γ spectrometers used for measuring the neutron time of flight and for separated gamma and neutron recordings are also discussed. (R.V.J.)

22786 TRUDY PYATOI NAUCHNO-TEKHNICHESKOI KONFERENTSII PO YADERNOI RADIOELEKTRONIKE, 18-23 DEK. 1961. (Reports of the Fifth Scientific Technical Conference on Nuclear Radioelectronics, Moscow, Dec. 18-23, 1961. Vol. 4. Automation of Measurements and Data Treatment). B. N. Moiseev, ed. Moscow, Gosatomizdat, 1963. 148p. (CONF-611201(Vol.4))

Seventeen papers cover the devices and techniques for processing experimental data. Descriptions are given of the design and performance of devices for recording coordinate particle input into the emulsion chamber for particle scattering, processing amplitude spectra, and measuring wire radioactivity. Descriptions include also the techniques for converting binary numerical data into decimal and new methods for processing data from multichannel systems. (R.V.J.)

22787 NOVYE NAUCHNO-ISSLEDOVATEL'SKIE RABOTY PO METROLOGII. INFORMATSIONNYI SBORNIK. IZMEREINYA IONIZIRUYUSHCHIKH IZLUCHENII. (New Metrological Investigations, Information Series No. 2. Measurement of Ionizing Radiations). K. K. Aglintsev, ed. Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. 71p.

Twenty articles are included on the design and performance of radiation detection instruments and techniques for measuring ionizing radiation. Separate abstracts are prepared for each article. (R.V.J.)

For abstracts of individual papers see: 22400, 22401, 22402, 22788, 22789, 22790, 22791, 22792, 22793, 22794, 22795, 22796, 22797, 22798, 22799, 22800, 23612, 23613, 23614, and 23615.

22788 UKG-1 CALIBRATED CALORIMETRIC UNIT. K. K. Aglintsev, L. P. Kul'kova, and E. A. Khol'nova. p.1-4 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

The UKG-1 unit was used for determining the value of the Curie, carrying out the measurements within the 50 to 50,000 μC range. The 3 independent differential γ calorimeters installed in the unit were provided with various absorbing Pb spheres. The unit was used for calibrating ^{60}Co sources. The upper limit of operation was set for radiation safety reasons. (TTT)

22789 USCh REFERENCE UNIT. A. A. Konstantinov, A. E. Kochin, and V. V. Perepelkin. p.4-7 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

The apparatus was used for measuring the activity and the emission of extended α and β emitters for determining their lack of uniformity. It consisted of a 4π counter with a vacuum system, a device for measuring the surface distribution of the activity and the required auxiliary equipment. The activity of the α emitters could be determined within the range from 10^{-12} to 10^{-5} C; the efficiency of recording the α and β particles reached about 95%. (TTT)

22790 THE UPGI- TYPE UNIT. A. F. Drichko, L. P. Zhukovskaya, F. M. Karavaev, and S. A. Rusinova. p.13-18 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

This apparatus was designed and built to calibrate the activity of reference and working γ emitting standards in the 10^{-4} to 1 C range, with a relative error of ±1%. Care was taken to compare emitters having similar isotopic composition and identical dimensions. The unit contained 2 ionization chambers, with capacities of 3.5 and 15 liters. (TTT)

22791 NEW APPARATUS FOR COMPARING REFERENCE AND MODEL RADIUM EMITTERS. A. F. Drichko, F. M. Karavaev, and S. A. Rusinova. p.18-21 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

One of the aims of the new device was the determination of the absolute activity of γ emitters. It involved the measurement of the Townsend ionization currents by using a compensation method. A check of the rated values by means of reference Ra standards showed that the error was about 1%. The apparatus was used to standardize working reference specimens and ^{60}Co γ emitters. (TTT)

22792 A REFERENCE CHAMBER FOR MEASURING THE EXPOSURE DOSE OF X RADIATION. G. P. Ostromukhova. p.21-4 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

A diaphragm-type ionization chamber, provided with a spherical electrode, was used in the construction of the reference measuring unit. The upper limit of measurement under saturation conditions was derived from the volt-ampere characteristics of the chamber which indicated that at a potential difference of 600 v, dose rates up to 300 R/min may be determined. The chamber was found useful for calibrating dosimetric instruments. (TTT)

22793 A UNIT FOR CALIBRATING DOSIMETERS HAVING γ RADIATION DOSE FIELDS FROM ~9 TO ~24 R/MINUTE. Z. P. Balon, R. F. Kononova, and N. T. Kosminina. p.28-31 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

A uniform radiation field was created by using a ^{60}Co γ emitter shaped in the form of a hollow cylinder; the radiation field was measured by means of a small graphite chamber. The results indicated that the maximum nonuniformity within the operating volume did not exceed 5%, the chamber was used with good success for dose rate measurements. (TTT)

22794 AN EXTRAPOLATION CHAMBER UNIT FOR MEASURING THE DOSE RATES OF PLANE β EMITTERS. K. K. Aglintsev, M. P. Kochina, and I. A. Uryaev. p.32-5 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

An apparatus was constructed for measuring the absolute absorbed dose rate in the 10 to 10,000 rad/hour range, emitted by plane β sources. It contained 32 and 16-cm diameter flat extrapolation chambers, a Townsend-type electric compensation measuring device and a special holder for the source. The small and the large chambers were used to measure the dose rate of emitters with an active surface of 0.73 to 11.92 and 3.18 to 47.74 cm^2, respectively. An error of 4 to 5% was obtained when the electrode was kept at a distance of >10mm. Sources of ^{90}Sr + ^{90}Y, ^{32}P, and ^{204}Tl were used for calibrating the apparatus. (TTT)

22795 A UNIT FOR INVESTIGATING β RADIATION DOSE FIELDS AND DOSE RATES FROM PLANE EMITTERS. K. K. Aglintsev, M. P. Kochina, and I. A. Uryaev. p.36-40 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

An apparatus containing several plane-parallel/ionization chambers of varying dimensions was built for studying plane β emitters with an active surface up to 5000 cm^2. An Al foil kept under a voltage of 180 v was used as the electrode at potential; the measuring electrode consisted of a Plexiglas disc coated with a graphite solution. Each of the

chambers was used for a different maximum β energy. Measurements were carried out with various β emitters with a maximum error of 7 to 10%, even when the radiation field was markedly uneven. (TTT)

22796 A UNIT FOR CARRYING OUT SPECTRAL AND DOSIMETRIC STUDIES ON PLANE β EMITTERS. K. K. Aglintsev and I. A. Uryaev. p.40-3 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

The new apparatus was designed to measure the dose rates of large but low-intensity plane β emitters. It contained a scintillation β spectrometer with a tissue-equivalent phosphor and was calibrated by means of the conversion line of ^{137}Cs. Measurements of $^{90}Sr + ^{90}Y$ emitters by this apparatus and by an extrapolation chamber agreed satisfactorily. (TTT)

22797 THE EFFECT OF THE SCATTERING OF NEUTRON RADIATION ON THE CALIBRATION OF DOSIMETERS AND EMITTERS. M. F. Yudin and A. P. Yanovskii. p.43-5 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

A new method was developed for studying the effect of neutron scattering in closed rooms, caused by the walls, floor, and ceiling of the room. The flux density was measured in 4 series of experiments: in the center of the 3.5 × 6 × 10 m room, with the source open; at the same location but covering the direct beam with a paraffin cone containing B_2O_3; in the street, at a distance of 3.15 m above the ground and 7 m from the building; and at the same location but covering the direct beam with the absolutely absorbing paraffin mixture containing B_2O_3. The flux density measurements of the Po-Be(α,n) source were carried out by means of the double moderation technique. The flux increase due to scattering was found to be $N_{scat} = 2.6 \times 10^{-3}R^2$ (%), where R is the distance of the measuring device from the source. (TTT)

22798 A FAST-NEUTRON DETECTOR, POSSESSING INSENSITIVITY TOWARD γ RADIATION. Yu. V. Ivanov. p.49-52 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

The difference in the duration and the shape of the scintillation pulses delivered by the photomultiplier on the basis of excitation of a stilbene single crystal by neutrons and γ quanta was the basis for designing a fast-neutron detector which was insensitive toward γ radiation. The n-γ coincidences from Po-Be and Pu-Be neutron sources were studied for this reason, separating out the effect of γ quanta. (TTT)

22799 PRODUCTION OF A CALIBRATED THERMAL NEUTRON FLUX. O. L. Andreev and I. A. Yaritsyna. p.63-6 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

An apparatus was built to create a strong thermal neutron flux for determining the flux density unit, using two Ra-α-Be sources in Pb shields and paraffin moderator. The uniformity and isotropicity of the flux within the cavity formed by the moderators was measured by the activity induced in an In foil. The found flux density of $\phi = 4.7 \times 10^3$ n/(sec.cm^2) is not considered to be precise because the cross section of the In, the self absorption and self reflection of the β particles are not sufficiently well known. (TTT)

22800 A NEUTRON DOSIMETRY APPARATUS. M. F. Yudin and A. P. Yanovskii. p.66-70 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

A neutron dosimeter containing tissue-equivalent and graphite ionization chambers was developed for measuring fast-neutron dose rates in the range of from 1 to 100 times the maximum permissible dose. Within the energy range from 0.3 to 14 Mev, the measurement error amounted to ±8%. An instrument with two moderators was used at very low dose rates, from 0.05 times the max. permissible dose up, which made possible the determination of the fast-neutron dose rate in the presence of a γ background with an error of ±(8 to 10%). The geometric and actual centers of the tissue-equivalent and graphite chambers coincided well within experimental error. The ionization current in the chamber was found to be only slightly dependent on the direction of the incidence. (TTT)

22801 THRESHOLD FOIL SPECTROSCOPY AT THE MITR MEDICAL FACILITY. R. A. Rydin and G. L. Brownell (Massachusetts Inst. of Tech., Cambridge). 8p. (CONF-654-77).

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Threshold foil measurements, using ten different threshold reactions, were performed in the Medical Therapy Facility Beam of the M. I. T. Reactor. The beam is highly thermal (R_{Cd} = 335) and has an integrated fast flux of the order of 10^{11} n/cm^2-sec. The differential neutron spectrum, in the range −1 to 15 Mev, was calculated from the data using the Weighted Orthonormal Method which was coded for the IBM-7090 computer. The following reactions were utilized: ^{237}Np (n,f); ^{238}U (n,f); ^{232}Th (n,f); ^{115}In (n,n'); ^{58}Ni (n,p); ^{27}Al (n,p); ^{28}Si (n,p); ^{24}Mg (n,p); ^{56}Fe (n,p); and ^{27}Al (n,a). All data were taken relative to the thermal flux by using thermal neutron reactions leading to the same product or a product emitting a similar energy gamma ray; i.e., ^{50}Cr with ^{115}In (plus a small relative efficiency correction). The absolute thermal flux calibration was obtained by β-γ coincidence counting of dilute gold foils. Long-lived products ($T_{\frac{1}{2}} > 1$ hr) were analyzed by gamma ray spectroscopy. Short-lived products ($T_{\frac{1}{2}} < 15$ min) were analyzed by recording decay curves with a 256 channel multiscaler and fitting activities to the curves with FRANTIC, a least squares program. Fissionable isotopes (including $\frac{1}{4}$ gm ^{237}Np foils) were analyzed by recording their gross fission product decay curves (E > 1.3 Mev) and fitting pseudo components of 3, 12, and 50 minutes plus background to these curves with FRANTIC. A ^{140}La calibration was used to relate the 50 minute component to the fission rate. The Orthonormal Method Code was tested on several sets of sample data and also compared with the Italian Iterative and Dierckx Methods using data from the Ispra-1 Reactor. Good agreement was obtained in these cases. (auth)

22802 DESIGN AND PROPERTIES OF THE DUKE WHOLE BODY COUNTER AND SCANNER. A. P. Sanders, F. J. Pircher, and T. Buffalo (Duke Univ. Medical Center, Durham, N. C.). 8p. (CONF-640609-3)

From Society of Nuclear Medicine 11th Annual Meeting, Berkeley, Calif.

Design features of a whole-body counter are described. The instrument provides a profile of radioactivity through the rate meter analog recorder system, a contour map of radioactivity through computer analysis, and a whole-body count. Results are reported from whole-body scans after the administration of ^{131}I. (C.H.)

22803 QUENCH CORRECTION BY AUTOMATIC EXTERNAL STANDARDIZATION. Ariel G. Schrodt, James A. Gibbs, and Robert E. Cavanaugh (Packard Instrument Co., Downers Grove, Ill.). 16p. (CONF-654-85)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The use of an external standard gamma radiation technique in determining the quenching correction factor for liquid scintillators is described. The selection of a gamma emitter for use with a closed sample vial is described. Cesium-147 was used in the quenching calibration of toluene– PPO– DMPOPOP solution. (R.E.U.)

22804 THE CADMIUM PHOTOACTIVATION DOSIMETER. C. D. Wagner (Shell Development Co., Emeryville, Calif.). 7p. (CONF-654-87)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Of the sixteen elements whose nuclei can be excited to metastable states by 3-Mev bremsstrahlung, Cd has potentially the most value for dosimetry. The metastable state, ^{111m}Cd, has a half life of 49 min and emits 149- and 247-kev photons to return to the ground state. Irradiation of one gram of Cd by enough 3-Mev bremsstrahlung to give a dose of one megarad in water gives sufficient Cd nuclei in the metastable state to register about three thousand counts per minute. This activity is enough to make Cd very useful as a small volume dosimeter in very inhomogeneous, high-intensity photon fields. Its performance is rather sensitive to various factors that change the photon energy distribution. (auth)

22805 CHARGE COLLECTION EFFICIENCY. Frank Keywell. 20p. (CONF-641210-5)

From American Physical Society Meeting, Berkeley, Calif.

A method is outlined for obtaining a first-order estimate of the back collection efficiency in a solid-state detectors from pulse height vs bias voltage data. (D.C.W.)

22806 IMPROVEMENTS IN OR RELATING TO DOSIMETERS. James Herbert Schulman. British Patent 981,888. Jan. 27, 1965. Priority date June 22, 1960, United States.

A device for measuring a dosage of ionizing radiation, such as γ rays or x rays, by the use of thermoluminescent materials or phosphors is described. The thermoluminescent material is mounted in an inert atmosphere in a hermetically sealed envelope, which is at least in part transparent or translucent. A heating means is included within the envelope, which may be electrically energized from an external source to heat the thermoluminescent material to above its glow temperature. The device may be worn as a personnel dosimeter and may be manufactured by mass production techniques. (A.G.W.)

22807 NEUTRON-MEASURING CHAMBER AND METHOD OF PRODUCTION. Claus-Benedikt v.d. Decken, Hans-Juergen Hantke, and Klaus-Peter Bachus (to Brown Boveri/Krupp Reaktorbau G.m.b.H.). German Patent 1,178,951. Oct. 1, 1964. Filed Apr. 10, 1962.

The fission chamber consists of helically wound ^{232}Th foils, the rims of which are provided with reinforcements of an elastic insulating material of such a thickness that insulation and a predetermined mutual distance is warranted. The insulating rim reinforcements are obtained by gluing viscous epoxy resin on the rim portions of the foils. (Gmelin Inst.)

22808 SENSITIVE POCKET DOSIMETER WITH RADIATION CELL AND BUILT-IN ELECTROMETER. Rudolf Hosemann and Harald Warrikoff (to Max-Planck-Gesellschaft). German Patent 1,185,302. Jan. 14, 1965. Filed Feb. 24, 1962.

The dosimeter consists of an evacuated housing, which encloses an unifilar string electrometer connected to the insulated electrode of a nuclear cell. The measurement is carried out by momentarily connecting the auxiliary electrodes of the electrometer to an auxiliary voltage source outside the housing, and simultaneously observing the string through an observation window. (Gmelin Inst.)

22809 EQUIPMENT FOR VIEWING RADIOACTIVE OBJECTS BY MEANS OF A TELEVISION APPARATUS. Max Eugen Wupper (to Fernseh G.m.b.H.). German Patent 1,186,903. Feb. 11, 1965. Filed Dec. 24, 1962.

The equipment described is for tracing the spread of radioactive substances, which are normally invisible. The equipment comprises the combination of a television apparatus with a device for the detection and visualization of radioactive radiation, e.g., an image converter. The detection instrument for the radioactive radiation and the television camera are arranged with respect to one another in such a way that the angle observed in relation to the object is nearly the same for both. A mirror, which is transparent to the radiation but which reflects the light into the objective of the camera is preferably interposed between the object and the detection instrument. (Gmelin Inst.)

Radiation Effects

Refer also to abstracts 23511 and 23512.

22810 (AD-422160) PROGRESS REPORT [ON RADIATION EFFECTS], OCTOBER 1963. (Litton Industries, Woodland Hills, Calif. Nuclear Radiation Effects Section). Contract AF33(657)-10584. 3p. $1.10(CFSTI).

A gyro preamplifier and F.E.T. electronic devices were irradiated to an exposure of ~4×10^{15} nvt during the period. The devices failed. With these irradiations the testing phase of the program was concluded making way for the analytical phase. (J.R.D.)

22811 DIODE RESISTANCE TO NUCLEAR RADIATON. Alvin B. Kaufman and Richard C. Eckerman (Litton Systems, Inc., Woodland Hills, Calif.). Electron. Ind., 22: 134-8 (Aug. 1963).

The forward and reverse conduction properties of the PD-105 microdiode were determined after exposure to fast neutrons in the General Dynamics ground test reactor; the diodes were intermittently energized during irradiation. It was found that energization of the Si diodes during exposure increases markedly the degradation of performance. (M.J.T.)

22812 SELF-RECORDING POCKET RADIOMETER FOR THE STUDY OF THE THYROID FUNCTION. A. A. Agafontsev. Med. Radiol., 10: No. 3, 73-8(Mar. 1965). (In Russian)

The description of a portable self-recording radiometer of the PKC-D type is given. The device is capable of recording continuous thyreogrammatic curves, expressing relationship between the ^{131}I content in the thyroid gland and the time element, this being of value for the study of fruste and extrathyroid affections of this gland, along with investigation into influences exerted upon its function by various physiological, pharmacological, psychic, and physical factors. The PKC-D unit includes two basic parts — the pocket radiometer proper and the rewriting arrangement. The device is fully transistorized, weighs 750 g, with electric supply furnished by a 1.5 v dry cell of the Saturn type. It is capable of performing continuous recording for 60 hours and operates within the temperature range of 0 to 50°C. The radiometer needs no permanent attention and the recording can be made in both clinical and ambulatory conditions. (auth)

22813 DETERIORATION OF SOLAR CELLS UNDER HIGH ENERGY ELECTRON BOMBARDMENT. Hideo Ono and Kenichi Takahaski (Nippon Electric Co., Ltd., Japan). NEC Res. Develop., No. 7, 39-46(Nov. 1964).

The effect of radiation damage on short-circuit current of solar cells was evaluated for n-on-p cells and p-on-n cells using 2-Mev electrons. The result shows that the average relative flux required to cause equal deterioration for the n-on-p cells is approximately twenty times as much as that for the p-on-n cells. A few estimations on the life of solar cells in space are given. The n-on-p cells with a suitable protective cover of sapphire can be expected to keep more than ninety percent of initial power output after one year exposure to cosmic radiation. (auth)

22814 THE EFFECTS OF IONIZING RADIATION ON TRANSISTOR GAIN. C. D. Taulbee (Bendix Corp., Southfield, Mich.), D. L. Nelson, and B. G. Southward. 29p. (CONF-641009-13)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

Transistor gain was reduced by ionizing radiation, which affected the transistor surface, and by displacement radiation, which caused lattice defects. For irradiation, x rays of photon energy less than 150 kev, which is below the en-

ergy necessary for displacement damage in silicon, were used. Experiments were performed on silicon dioxide passivated silicon planar transistors with open leads, in a normal amplifying mode and with other junction bias conditions. Both a-c and d-c gain measurements at various injection levels showed a gain degradation dependence on the operating bias conditions. Open leads and back-biasing of each junction during irradiation resulted in considerable damage, with almost complete recovery occurring in most transistors tested when the base emitter junction was forward-biased. Many of the characteristics of the radiation damage observed can be explained by Atalla's model that charge collection at the surface causes a widening of the space charge region, thus increasing the recombination-generation current. (auth)

22815 TRANSIENT RADIATION EFFECTS IN SEMICONDUCTOR DEVICES. J. W. Crowe and A. J. Saur (Atomics International, Canoga Park, Calif.). 60p. (CONF-641009-11).

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

Transistors in conventional simple circuits were exposed to bursts of x radiation from a 600 kv flash x-ray machine. Analyses of the circuit responses are given in terms of electrical equivalent circuits. Electrical and radiation tests are compared. (auth)

22816 DISPLACEMENT DAMAGE IN SILICON AND GERMANIUM TRANSISTORS. G. C. Messenger (Northrop Corp., Newbury Park, Calif.). 33p. (CONF-617-19)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

An experimental and theoretical analysis of neutron damage to germanium and silicon transistors is presented. A combination of experimental data and first order theory was used to determine lifetime damage constant as a function of neutron energy. Two separate effects attributable to the recombination centers were identified. At low bias levels recombination centers present in the emitter diode field region cause a very large decrease in current gain. At higher levels of emitter bias current recombination centers present in the base region cause a reduction in current gain. The temperature dependence of current gain is stronger when emitter region recombination is the dominant process than when base region recombination is most effective. The damage thresholds of silicon transistors can be increased by operating at high ambient temperatures. The characteristics of the recombination centers were determined from the experimental data and agree well with values previously obtained by measurements on bulk semiconductor samples. Two discrete recombination levels in silicon and two discrete recombination levels in germanium are shown to determine the dependence of transistor current gain on neutron radiation. (auth)

22817 A STUDY OF THE TEMPERATURE DEPENDENCE OF RADIATION DAMAGE TO TRANSISTOR GAIN AND LEAKAGE. Francis T. Lynch and Alton L. Long (Burroughs Corp., Paoli, Penna.). 7p. (CONF-617-20)

From Special Technical Conference on Nuclear Radiation Effects, Seattle, July 1964.

Empirical functions are developed to relate transient leakage and permanent gain degradation to temperature and to gamma flux rate and integrated neutron flux, respectively. This development was based on an experiment conducted at the Sandia Pulsed Reactor Facility, using two types of silicon planar transistors. The exposure matrix consisted of five dose levels at each of five temperatures between –50 and 200°C. The equations which fit the data are compared to the established single-temperature relations, and the thermally sensitive terms are discussed. Factors limiting the application of these equations to other devices are also considered. (auth)

ISOTOPE TECHNOLOGY

General

22818 (ORNL-3650(p.221-38)) ISOTOPE DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

Research and development are reported on nuclear analysis, application of radioisotopes in analytical chemistry, determination of gamma-emitting nuclides by electronic spectra, the curium program, radioisotope production and separation, and electromagnetic stable-isotope separation, and electromagnetic stable-isotope separations. (J.R.D.)

22819 (ORNL-TM-1047(p.58-9)) TRANSPLUTONIUM ELEMENTS — PRESENT AVAILABILITY. J. S. Lichliter (Lawrence Radiation Lab., Univ. of California, Berkeley).

The availability of berkelium and californium isotopes is discussed. At present, berkelium-249 is in very short supply. Laboratories with ^{252}Cf on hand are listed. (P.C.H.)

22820 (ORNL-TM-1047(p.83-6)) STABLE ISOTOPE PROCUREMENT. P. V. Arow (Oak Ridge National Lab., Tenn.).

Procedures and requirements in the sale of stable isotopes are discussed. Conditions for the loan of certain electromagnetically separated stable isotopes to domestic users are listed. 26 isotopes that are of relatively high natural abundance and represent relatively low concentrations as separated samples are available for sale only. (P.C.H.)

22821 (ORNL-TM-1047(p.87-92)) RESEARCH POOLS. F. N. Case (Oak Ridge National Lab., Tenn.).

Several pools of isotopes specifically assigned for research uses are maintained by ORNL for the AEC, Div. of Research. These materials are available to research programs when the use is approved by the Div. of Research. The Cross Section Pool (CSP) and Heavy Element Research Pool are discussed. The CSP is an inventory of stable isotopes, preparation of which is scheduled jointly by the Isotope Development Center, the Division of Research, and the Cross Section Committee. Stocking and maintaining the CSP inventory is the concern of the Calutron Separation Program at the Isotope Development Center. The Heavy Element Research Pool is maintained for the Div. of Research and continues its identity as a separate pool because of special handling problems. The pool is primarily concentrated at ORNL; however, other AEC facilities may be involved in preparing samples. (P.C.H.)

22822 (ORNL-TM-1047(p.93-7)) RESEARCH SAMPLES PROGRAM. L. K. Hurst (Argonne National Lab., Ill.).

Various facilities and equipment available at Argonne for special research are discussed. The capabilities of the various production groups and their needs are stressed. Brief descriptions are given of such specialized equipment as the 60-in. cyclotron, the 100-in. mass spectrometer, the electromagnetic isotope separator, the synchrotron, the Janus reactor, and the chemistry high-level hot laboratory. (P.C.H.)

22823 (ORNL-TM-1047(p.106-8)) OLD ARMOR PLATE AND LEAD. P. S. Baker (Oak Ridge National Lab., Tenn.).

Information that is out of the ordinary, but for that reason may be of particular interest or value is reported. This includes information on the availability of old armor plate from old battleships that may be suitable for shielding purposes. In Holland there is a batch of about 75 tons of lead that has recently been raised from a ship sunk in 1806 and is free from fallout. Mention is also made of the separation of a quantity of Nd from fission products that have an abnormal isotopic distribution. The big differences are in the lack of 142 and higher ratios of 143 and 145. (P.C.H.)

22824 (ORNL-TM-1047(p.144-6)) AEC COSTING AND PRICING POLICIES AND PRACTICES FOR RESEARCH MATERIALS. L. S. Lenderman (Atomic Energy Commission, Washington, D. C.).

General costing and pricing practices in the AEC for research materials are given. The costing principles and procedures are based on direct material costs, processing and other costs, reactor operating costs, contractors' overhead costs, and non-fund costs, such as net fuel costs and depreciation. The pricing policy provides that materials and services furnished to others shall be priced at the higher of full cost recovery or current commercial prices so long as these prices will not discourage the use of such materials and services or the development of sources of supply of the materials or services, and will not discourage research and development. (P.C.H.)

Industrial Applications

Refer also to abstracts 22718 and 24000.

22825 (IDO-10042) SUITABILITY OF POTATO PRODUCTS PREPARED FROM IRRADIATED AND CHEMICALLY INHIBITED POTATOES. George A. Freund (Western Nuclear Corp., Idaho Falls, Idaho). Feb. 1965. Contract AT(10-1)-1198. 37p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Untreated chemically inhibited and irradiated potatoes (Russet Burbank Variety) were prepared into frozen french fries and dehydrated slices, granules, and flakes. The treatments produced generally comparable processed products. Irradiated potatoes and some of their products tend to maintain somewhat better texture than chemically inhibited potatoes, but are more prone to discoloration. Eight months after harvest, irradiated potatoes produced satisfactory dehydrated granules and slices and frozen french fries, but unacceptable flakes. After six months of product storage, only french fries were still commercially acceptable. Twelve months after harvest irradiated potatoes produced satisfactory slices and french fries, but flakes of marginal color; (no granules were made.) After two months of product storage only slices were still commercially acceptable. (auth)

22826 (NP-14984) INDUCED RADIOACTIVITY IN FOOD AND ELECTRON STERILIZATION. Richard A. Meyer (Army Natick Labs., Mass.). Apr. 1965. 49p. (FD-6)

An extensive survey was made of the literature on activity induced in foods by the use of high energy electrons. This survey indicates that food irradiated with 24 Mev electrons contains less than a five percent increase in the radioactivity level over that present before irradiation. A compilation of the experimentally measured amount of activity induced in various foods as a function of initial electron energy is presented in various tables. An equation has been developed which will predict the average amount of induced activity as a function of initial electron energy, dosage, and elemental abundance. This equation yields results within the variation of trace elements in foods. To aid in the use of these equations, tables of trace element composition in various foods are presented. These were compiled for use with equations developed in the text due to a lack of any single source of food trace element composition in the literature. Although activity induced in cans is not a food consumption problem, the amount of activity present immediately after irradiation can produce a handling problem. It appears that the best solution to this problem may be the use of aluminum cans or an aluminized plastic packaging material. In general it was found that sterilization of food with 24 Mev electrons will produce a slight increase in the activity level of the food. Such an increase is insignificant when compared to the natural activity in food or the two to ten fold increase in activity by

the use of certain food additives. It can be stated that no radioactivity is induced in foods up to around 14 Mev. Current research is aimed at determining this threshold value. (51 references) (C.H.)

22827 (TID-21600) STUDY OF IRRADIATED-PASTEURIZED FISHERY PRODUCTS. Period Covered: October 1, 1963–September 30, 1964. Joseph W. Slavin and Louis J. Ronsivalli (Gloucester Technological Lab., Mass.). Nov. 30, 1964. Contract AT(49-11)-1889. 57p. Dep.; $3.00(cy), 2(mn) CFSTI.

Results are reported from studies on the radiopasteurization of fish. Data are presented on the optimum dose and acceptance of irradiated pollock, ocean perch, cod, and mackeral fillets; the effect of pre-irradiation quality on post-irradiation shelf life of cod fillets; the suitability of plastic materials for packaging irradiated fishery products; the changes that occur in flavor and odor as a result of irradiation and storage; and the bacterial quality of irradiated samples. Acceptability studies on haddock fillets stored for two and four weeks at 33°F after irradiation at 250,000 Rads showed there was no significant difference between the irradiated samples and top quality fresh frozen controls and that 30-day-old irradiated haddock fillets have a level of acceptability high enough to meet requirements. (C.H.)

22828 UTILIZATION OF RADIOISOTOPES AND RADIATION IN APPLIED ENTOMOLOGY. R. Impens, E. Francois, and A. Riga. Ann. Gembloux, 70: 45-63(1964). (In French)

The utilization of radioisotopes and radiation in applied entomology is reviewed with emphasis on methods using the nuclear properties of matter and by defining the advantages and the limitations. (J.S.R.)

22829 THE USE OF RADIOISOTOPE RADIATIONS FOR FOOD CONSERVATION. H. Mohrhauer and W.-J. Schmidt-Kuester (Bundesministerium fur Wissenschaftliche Forschung, Bad Godesberg, Ger.). Atomwirtschaft, 10: 137-9 (Mar. 1965). (In German).

The irradiation of foodstuffs for sterilization and pasteurization is a field of application for which radioisotopes with activities in the megacurie range will be necessary. It is shown that although the radiation produced by accelerators is in many cases suitable for the conservation and sterilization of food the use of ^{60}Co gamma rays appears to be still gaining ground in the USA. The essential investigations in this field were carried out in the USA. Two main programs were pursued: investigations by the Army into the sterilization of food with high doses of radiation and investigations by the USAEC into the sterilization of highly perishable fruit and fish with relatively small doses of radiation in order to prolong possible storage life. In Canada an important program was pursued involving the irradiation of potatoes to prevent germination. The irradiation of wheat provided a further application there. In Europe work was so far chiefly dedicated to basic research. The main work of individual European countries is discussed along with questions of cost and the psychological reaction of the consumer. (auth)

22830 THE PHYSICAL FOUNDATIONS OF FORMATION DENSITY LOGGING (GAMMA-GAMMA). J. Tittman and J. S. Wahl (Schlumberger Well Surveying Corp., Research Center, Ridgefield, Conn.). Geophysics, 30: 284-94(Apr. 1965).

The principal modes of interaction between gamma rays and atoms are reviewed. Special attention is paid to the need for using only Compton scattering in order to determine the electron density of a sample or earth formation and for eliminating chemical composition effects arising from low-energy photoelectric absorption. The nature of the so-called Z/A effect is discussed in relation to the conversion of electron density, the immediately measured quantity, into bulk density. Since gamma diffusion results from repeated scattering in the formation, the Boltzmann transport equation is used as the framework for understanding empirical observations. The method-of-moments solution provides both an understanding of the spatial variation of the gamma energy spectrum and also a basis for reducing the Boltzmann equation to the simple diffusion equation. A discussion is presented comparing experimental results with the diffusion solution for the point-source-at-plane-interface problem. The comparison confirms the validity of the mathematical and physical approximations made. (auth)

22831 RADIATION PASTEURIZATION OF SEAFOOD. I. THE COMBINED EFFECT OF SODIUM BENZOATE AND IRRADIATION FOR RETARDING MICROBIAL GROWTH IN DOVER SOLE (MICROSTOMUS PACIFICUS). J. S. Lee, M. A. Shiflett, and R. O. Sinnhuber (Oregon State Univ., Corvallis). Intern. J. Appl. Radiation Isotopes, 16: 221-6 (Apr. 1965).

The microbial spoilage of Dover sole stored at 42 to 44°F was retarded when the fish that had been treated with 0.1 percent (1000 ppm) sodium benzoate was given pasteurizing doses of γ radiation. The benzoate by itself had no microbicidal effect. Samples receiving 0.1 Mrad required 6 days to reach a count of 10^6 microorganisms per gram. A similar sample containing benzoate required 9 days to reach the same count. The untreated sample receiving 0.3 Mrad required 10 days, while the benzoate-treated sample took 19 days to reach a count of 10^6. Fourteen days were required for the 0.5 Mrad samples to reach this count, whereas the benzoate-treated sample did not show growth until the 27th day. (auth)

22832 CHOICE OF OPTIMAL PARAMETERS FOR RADIOISOTOPE DEVICES USED IN THERMOPHYSICAL INVESTIGATIONS. Ya. N. Basin, R. A. Makarov, and N. V. Seleznev (Inst of Physics, Moscow). Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR, 8: 157-62(Feb. 1965). (In Russian)

The method of choosing optimal parameters for radioisotopic devices using γ radiation from closed sources, which may be applied to thermodynamic problems are discussed. (auth)

22833 RADIOISOTOPES AS AIDS TO METALLOGRAPHY. A. A. Cochran and V. R. Miller (Bureau of Mines, Rolla, Mo.). J. Metals, 15: 914-17(Dec. 1963).

Some variations of two radiotracer techniques (autoradiography and radiometric analysis) and their applicability to steel research are discussed and some typical results are outlined. The relative advantages of macroautoradiography, microautoradiography, radioactivity measurements of surfaces, and radiometric analysis of thin samples are considered. For macroradiography steel samples were prepared that contained either ^{141}Ce and nonradioactive S or ^{35}S and nonradioactive Ce. Very small quantities of radioactive material were sufficient for the studies. The autoradiographs showed that most of the Ce and a significant fraction of the S added to the melt migrated into the crucible. Microautoradiography differs from macroautoradiography only in that a fine-grained photographic film is attached to the specimen, developed in place on the specimen, and inspected under a microscope. Several different techniques of radiometric analysis were employed. One technique involved measuring the amount of radioactivity at the surface of a polished steel specimen mounted in plastic. In the ingots studied, ^{14}C and ^{35}S sulfur were found to be fairly well distributed, but ^{141}Ce was found to be segregated in the bottom part of some ingots. On the basis of the results obtained by the use of these radiotracer techniques, it is suggested that radioisotopes can be employed as effective supplements to conventional metallography in many specific problems of metallurgy. (TCO)

22834 A RADIOMETRIC DEVICE TO CONTROL THE DISTANCE OF LOADING CRANES. K. E. Duftschmid, W. Attwenger, and J. Steidl (Osterreichische Studiengesellschaft fur Atomenergie GmbH, Reaktorzentrum, Seibersdorf, Vienna). Kerntechnik, 7: 114-16(Mar. 1965). (In German).

If more than one loading crane is used on one track the

danger of collision arises, especially if the cranes are travelling at high speed. Control equipment using a scintillation counter with a ratemeter circuit, designed to give a very high safety factor, is described. The time of distance indication is 0.3 sec and measurement of the distance is within ±5%. (auth)

22835 RADIOISOTOPES AND THEIR INDUSTRIAL APPLICATIONS. H. Piraux. Translated from French by L. B. Firnberg. Eindhoven, Netherlands, N. V. Philips' Gloeilampenfabrieken, 1964. 284p.

The most important properties of radioisotopes, the precautions to be taken when using them, and the methods to be adopted in order to apply them in the fields of measurement and research are discussed. Topics covered include: production and properties of radioisotopes, physiological effects of radiation, the action of radioisotopes on matter and protective measures, working conditions, radiation detectors, auxiliary equipment, choice of isotopes and detectors, physical applications of ionizing radiation, radioisotopes and chemistry, radioisotopes as tracers, measurement of thickness and density, level indicators, gamma radiography, autoradiography, and other applications and techniques. (M.C.G.)

22836 NUCLEAR METHODS APPLIED TO ORE BENEFICIATING PROCESSES, PRESENT AND FUTURE. Jack G. Crump (Nuclear-Chicago Corp., Des Plaines, Ill.). 10p. (CONF-650203-4)

From National AIME Meeting, Chicago.

Uses of radiation for gaging solids content in process slurries and level in crushers are discussed, along with moisture analysis of bulk materials in beneficiating and agglomerating processes. Continuous, qualitative and quantitative analysis of concentrate by activation methods is considered. Theories of these measurements are outlined and their uses in ore processing emphasized. (M.C.G.)

22837 VIRUSES AND RICKETTSIA IN FOODS AND THE POSSIBLE ROLE OF RADIATION PRESERVATION. Dean O. Cliver (Univ. of Chicago). 13p. (CONF-640909-5)

From International Conference on Radiation Preservation of Foods, Boston.

The etiology of food-borne outbreaks of virus and rickettsial diseases is discussed, with emphasis on poliomyelitis, infectious hepatitis, and Q-fever caused by Coxiella burnelii. The possibility of eliminating these organisms from foods through radiation processing is discussed. Available data on the radiosensitivity of viruses are reviewed. The possibility of inducing exotic mutants of viruses by exposure to sub-lethal radiation doses is considered. (C.H.)

22838 WORLD-WIDE STATUS OF THE TREATMENT OF FOODS BY IONIZING ENERGY. Samuel A. Goldblith (Massachusetts Inst. of Tech., Cambridge). 24p. (CONF-640909-11)

From International Conference on Radiation Preservation of Foods, Boston.

Developments in the radiation processing of foods are reviewed. Emphasis is placed on methods for reducing side effects in irradiated foodstuffs, methods of achieving dose reduction, and combinations of thermal and ionizing radiations in processing foods. The cost of radiation sources for food irradiation facilities is discussed. (C.H.)

Power Application

Refer also to abstracts 24058 and 24065.

22839 (ORNL-3669) PREPARATION OF A CESIUM (^{137}Cs) BOROSILICATE GLASS POWER SOURCE. C. L. Ottinger, E. E. Pierce, and R. W. Schaich (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 17p. Dep.; $2.00(cy), 1(mn) CFSTI.

A ^{137}Cs borosilicate glass power source with 125 watts thermal output was prepared. Techniques for the preparation of the fuel material, its casting into the proper form, and the fabrication of the final source capsules were developed. The chemical processing, fuel preparation, source encapsulation, heat output measurements, capsule leak-rate determinations, and measurements on the loaded shipping cask are described. (auth)

Separation and Production

See also CHEMISTRY — Separation Processes and Procedures.

Refer also to abstracts 23355 and 23999.

22840 (IS-1059) THE NITROGEN ISOTOPIC SEPARATION FACTORS OF VARIOUS ORGANIC AMINES ON AMBERLITE IR-120 CATION EXCHANGE RESIN. Duane D. Nowlin and Jack E. Powell (Ames Lab., Iowa State Univ. of Science and Tech.). Nov. 1964. Contract W-7405-eng-82. 91p. Dep.; $4.00(cy), 2(mn) CFSTI.

Ion-exchange displacement chromatography was used to measure the nitrogen isotopic separation factors of ten organic amines and ammonium hydroxide. A column of Amberlite IR-120 H^+-form resin was used, and the aqueous amine solutions were approximately 0.125N. The separation factors of the compounds investigated are: ammonium hydroxide, 1.0254; methylamine, 1.0223; ethylamine, 1.0218; n-propylamine, 1.0199; iso-propylamine, 1.0197; n-butylamine, 1.083; dimethylamine, 1.0174; diethylamine, 1.0172; dipropylamine, 1.0159; trimethylamine, 1.0130; and triethylamine, 1.0117. According to the theory presented, the isotopic separation factor reported for most compounds is actually a result of three independent isotopic equilibrium reactions. However, for the amines studied in this work, only one of these reactions contributes significantly to the measured separation factor. This is the isotopic equilibrium occurring in the solution phase between amine ions and undissociated amine molecules. This theory is used to explain the separation factors reported in this work and also the concentration and temperature dependence of α, reported by many other workers. (auth)

22841 (ORNL-TM-1047) RESEARCH MATERIALS COORDINATION AND PLANNING MEETING, NOVEMBER 14–15, 1963. P. S. Baker, comp. (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 150p. Dep.(mn); $4.00(cy), 3(mn) CFSTI.

Twenty-six articles are included; separate abstracts were prepared for 25. One article on americium capability at Rocky Flats was previously abstracted in NSA as 18: 23706. (P.C.H.)

For abstracts of individual papers see: 22098, 22283, 22284, 22819, 22820, 22821, 22822, 22823, 22824, 22842, 22843, 22844, 22845, 22846, 22847, 22848, 22849, 22850, 22851, 22852, 22853, 22854, 22855, 22856, and 22926.

22842 (ORNL-TM-1047(p.2-14)) ELECTROMAGNETIC ISOTOPE SEPARATIONS. L. O. Love (Oak Ridge National Lab., Tenn.).

Descriptions are given of electromagnetic separators, what is being done with them, what it costs to operate them, and what might be done with them should the need arise. (P.C.H.)

22843 (ORNL-TM-1047(p.15-22)) THERMAL DIFFUSION. W. R. Rathkamp (Oak Ridge National Lab., Tenn.).

The production of enriched radioisotopes, primarily inert gas isotopes, by thermal diffusion is discussed. Thermal diffusion is used to enrich isotopes that either cannot be produced by other separation methods or are more costly when prepared by alternate means. Experience has shown that very little maintenance or operational attention is needed by a well designed thermal diffusion cascade. (P.C.H.)

22844 (ORNL-TM-1047(p.23-9)) ISOTOPES OF HYDROGEN, LITHIUM, BORON, NITROGEN, OXYGEN. J. S. Drury (Oak Ridge National Lab., Tenn.).

The production, availability, and cost for the isotopes of

H, Li, B, N, and O are discussed. Special attention is given to the production of ^{17}O and ^{18}O by distillation of oxygen-containing species. (P.C.H.)

22845 (ORNL-TM-1047(p.30-1)) PRODUCTION OF HEAVY WATER. C. H. Ice (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.).

The production, availability, and cost of heavy water at the Savannah River Plant are discussed. Heavy water is extracted from the Savannah River and concentrated to about 10% D_2O by the dual temperature H_2S/H_2O exchange process. Further concentration, to specification quality of 99.75 mole % minimum is done by vacuum distillation. Maximum capacity of the plant would be about 540 tons per year if the whole plant were in operation. The price of D_2O at present is about $13.60 per pound. (P.C.H.)

22846 (ORNL-TM-1047(p.32-9)) HELIUM-3 AND OTHER GASEOUS ISOTOPES. W. J. Haubach (Mound Lab., Miamisburg, Ohio).

Graphs are presented on the preparation and chemical purification of He, separation of Ar and Ne isotopes by thermal diffusion, concentration of high- and intermediate-level ^{13}C by thermal diffusion, and separation of Xe isotopes by thermal diffusion. ^3He enriched to 99.9996% with less than 10^{-10}% tritium is available from Mound. (P.C.H.)

22847 (ORNL-TM-1047(p.40-52)) ^{238}Pu, ^{234}U, AND NATURALLY OCCURRING RADIOISOTOPES. R. E. Vallee (Mound Lab., Miamisburg, Ohio).

The current status on the separation, purification, and availability of ^{238}Pu and ^{234}U is presented in graphical form. Graphs on the separation and purification and planned availability of ^{227}Ac are also included. (P.C.H.)

22848 (ORNL-TM-1047(p.53-7)) CHEMICAL AND SPECIAL PROCESSING OF ELECTROMAGNETICALLY SEPARATED ISOTOPES. H. R. Gwinn (Oak Ridge National Lab., Tenn.).

Problems and techniques in the chemical and special processing of electromagnetically separated isotopes are discussed. Special attention is given to Pu, U, Ca, Am, and Np isotopes and Ti and Zr crystals. (P.C.H.)

22849 (ORNL-TM-1047(p.60-1)) TRANSURANIUM ISOTOPES NATIONAL TRANSURANIUM PROGRAM. A. Chetham-Strode (Oak Ridge National Lab., Tenn.).

The National Transuranium Program includes the interim irradiations of ^{239}Pu, ^{242}Pu, and ^{241}Am, the irradiation of kilogram quantities of ^{239}Pu to produce High Flux Isotope Reactor (HFIR) targets of ^{242}Pu, ^{243}Am, and ^{244}Cm, and the HFIR irradiation of such targets to produce gram quantities of berkelium and californium and smaller amounts of heavier transuranium isotopes and other transuranium isotopes of special interest. The present status and tentative schedule for these irradiations (revised to June 1954) are tabulated. The isotopes listed are being produced for research activities, their distribution, foreign and domestic, is limited to small quantities for this purpose. (P.C.H.)

22850 (ORNL-TM-1047(p.62-8)) THE OAK RIDGE NATIONAL LABORATORY CURIUM PROGRAM. E. Lamb (Oak Ridge National Lab., Tenn.).

The recovery and purification of ^{242}Cm and ^{244}Cm, fabrication of isotopic power sources containing curium, and their characterization with respect to normal operational and extreme conditions are discussed. The operations involved in the preparation of ^{242}Cm heat sources are ^{241}Am target fabrication, reactor irradiation, recovery, and purification of ^{242}Cm-^{241}Am from irradiated targets, and preparation of the source form. A flowsheet for the preparation of ^{242}Cm heat sources, target capsule assembly, irradiation assembly, Tramex process flow-sheet, source fabrication facility, and ^{242}Cm power source program source fabrication operations are illustrated. (P.C.H.)

22851 (ORNL-TM-1047(p.72-6)) ACCELERATOR-PRODUCED ISOTOPES. J. J. Pinajian (Oak Ridge National Lab., Tenn.).

The production of carrier-free radioisotopes in the ORNL 86-in. cyclotron is discussed. The cyclotron continues to be the prime source (for all practical purposes the only source) of neutron deficient radioisotopes. These isotopes give rise to proton emission that result in 0.511 Mev annihilation quanta or electron capture that results in characteristic x-ray emission. Data on targets used and the experimental yields in mC/hr are tabulated. (P.C.H.)

22852 (ORNL-TM-1047(p.81-2)) THE PROPOSED ORNL RADIONUCLIDES SEPARATIONS LABORATORY. A. F. Rupp (Oak Ridge National Lab., Tenn.).

The proposed Radionuclides Separations Laboratory (RSL) at ORNL is briefly discussed. Particular consideration is given to the kinds of special research materials that would not be produced in such a facility. The $5.5 million facility is being designed around several electromagnetic separation process machines, adapted for remote control work with α-β-γ-neutron emitting nuclides. (P.C.H.)

22853 (ORNL-TM-1047(p.113-16)) PREPARATION OF SPECIAL ISOTOPES AND OTHER SERVICES AT BROOKHAVEN. L. G. Stang, Jr. (Brookhaven National Lab., Upton, N. Y.).

The development and production of what is called special isotopes at Brookhaven is discussed. Their applications lie largely in the field of medicine, although some are used industrially. A feature in common is that all require chemical processing following irradiation. Another chief feature is that none is supplied commercially by any other source of supply in the U.S. (at least not in the form supplied by Brookhaven). The isotopes are listed according to production method. (P.C.H.)

22854 (ORNL-TM-1047(p.117-22)) CYCLOTRON SERVICES. J. E. Beaver (Oak Ridge National Lab., Tenn.).

Operation of the 86-in. cyclotron for radioisotope production is discussed. Advantages of different types of targets are described. These targets include high-current flat-plate, capsule, and window targets. (P.C.H.)

22855 (ORNL-TM-1047(p.127-36)) PRODUCTION QUANTITIES OF ISOTOPES BY GASEOUS DIFFUSION, MOLECULAR DISTILLATION, AND CHEMICAL EXCHANGE. S. A. Levin (Oak Ridge Gaseous Diffusion Plant, Tenn.).

The separation of isotopes of W, Mo, Xe, Cl, Li, B, and K by gaseous diffusion, molecular distillation, and chemical exchange is discussed. The rate and cost of production of each isotope by these methods are given. (P.C.H.)

22856 (ORNL-TM-1047(p.137-43)) THE GAS CENTRIFUGE. E. C. Evans (Oak Ridge Gaseous Diffusion Plant, Tenn.).

The use of gas centrifuges for radioisotope separations is discussed. Data on the important process parameters for the separation of U isotopes with gaseous diffusion and gas centrifugation are tabulated. Considerations influencing the choice of process gas for gas centrifuge are listed. Special attention is given to the Zippe type centrifuge, which combines the separator, pump, and seal all in one machine. (P.C.H.)

22857 PRODUCTION OF SPECIAL RADIOISOTOPES. Nagao Shibata (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 10: No. 4, 65-9(Apr. 1964). (In Japanese)

The production of special radioisotopes is described. Fourteen pure radioisotopes (^{24}Na, ^{32}P, ^{198}Au, etc.) are available at present from the Japan Atomic Energy Research Institute. In addition, several special isotopes are also produced by the photonuclear reaction, (n,p) reactions, hot-atom reactions, and secondary reactions of ^3H. ^{137}Cs produced by the photonuclear (γ,n) reaction in the Linac. The product is of 99.9% radiochemical purity with a specific activity of about 10 mC/g Cs. High-specific-activity ^{24}Na and carrier-free ^{58}Co, ^{64}Cu, and ^{67}Cu are produced by the (n,p) reactions. High-specific-activity ^{32}P, ^{51}Cr, ^{64}Cu, and $^{55+59}Fe$ are produced by hot-atom reactions; phosphates, potassium chromate, copper phthalocyanine, and ferrocyanates are used as target materials, respectively. En-

ergetic tritium from the (n,α) reaction in lithium carbonate causes the secondary nuclear reaction in the reactor. ^{18}F and ^{28}Mg are thus obtained from the $^{16}O(H\text{-}3,n)$ and $^{25}Mg(H\text{-}3,p)$ reactions, respectively. (NSA of Japan)

22858 SEPARATION OF CHLORINE ISOTOPES IN AQUEOUS LiCl, NaCl AND HCl SOLUTIONS. B. P. Konstantinov and E. A. Bakulin (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Fiz. Khim., 39: 592-6(Mar. 1965). (In Russian)

Separation of stable chlorine isotopes ($^{35}Cl^-$, $^{37}Cl^-$) in aqueous LiCl, NaCl, and HCl solutions at 50°C was carried out by the ion mobility method in about 1.2-mm dia columns filled with quartz sand of 20 to 40 μ grams. $K_2Cr_2O_7$ was used as indicator (a clearly defined boundary stable in the presence of an electrical field for all the LiCl, NaCl, and HCl concentrations investigated was set up between the Cl^- ions and $Cr_2O_7^{--}$). On changing the concentration (g eq/l) of the LiCl solution from 1 to 15.1 the value of α changed from 0.17 to 0.26%. With NaCl changed from 1 to 6.1, α changed from 0.16 to 0.22%. With HCl changed from 2.1 to 12.6, α changed from 0.12 to 0.16%. It was found that the relative differences in mobility of isotopic chlorine ions in LiCl and NaCl solutions are within experimental error independent of the nature of the electrolyte. The value of α for chlorine in HCl solutions for all the HCl concentrations investigated was 40% lower than in LiCl and NaCl solutions. (auth)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 23164 and 23355.

22859 (ORNL-3766) MATHEMATICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1964. A. S. Householder and H. P. Carter (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 89p. Dep.; $3.00(cy), 2(mn) CFSTI.

Research progress in mathematics and computer programming is summarized. Developments in statistics research, computer program applications, and statistical programming are summarized. A review of computing services is included. (J.R.D.)

22860 APPLICATION OF ANALOG COMPUTERS MNB-1 TO SOLUTION OF NUCLEAR POWER PROBLEMS. V. P. Konchits and V. M. Shadskii (Inst. of Heat and Mass Exchange, Minsk). Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR, 8: 110-13(Jan. 1965). (In Russian)

The expediency of application of analog computers MNB-1 and MN-7 working simultaneously for calculations of nuclear power plant problems is shown. Possibilities of analog computers are essentially extended by application of reactor simulator of a particular scheme. The investigation of stability is carried out for the reactor with temperature feedback, and the frequency response is presented. Errors in simulation of linear systems are estimated by solving the problem on the isotopic composition of the fuel element. (auth)

22861 PROGRAM CONVERTS ON-LINE COMPUTERS INTO MEGACHANNEL ANALYZERS. Nucleonics, 23: No. 4, 66-7(Apr. 1965).

A program for the SDS 910 computer at Brookhaven was developed that enables the on-line computer to function as an analyzer with 4,000,000 channels and offering good data rates and feedback display features. The program can be adapted for any modern digital computer. The specifications of the BNL software analyzer are given. (L.B.S.)

22862 THE ON-LINE COMPUTER COUNTER AND DIGITALIZED SPARK-CHAMBER TECHNIQUE. S. J. Lindenbaum. Phys. Today, 18: 19-24; 26-8(Apr. 1965).

Experiments are described in which $K^{\pm}$-p, $\pi^{\pm}$-p, p-p, and $\bar{p}$-p elastic scattering at 7 to 20 Bev/c was investigated, using an on-line computer to analyze the data obtained with scintillation-counter hodoscopes. The use of digitized spark-chamber hodoscopes and sonic spark chambers is also briefly discussed. (D.C.W.)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 21791 and 24093.

22863 (AD-606809) REPORT OF NRL PROGRESS. (Naval Research Lab., Washington, D. C.). Sept. 1964. 52p. $3.00(CFSTI).

A separate abstract was prepared for the section on NRL high-level radiation laboratory. Other sections included, for which no abstracts were prepared, are concerned with pressure effects in algal growth, problem notes on chemistry, mechanics, metallurgy and ceramics, optics, radio and solid state physics, and supporting techniques. (J.R.D.)

For an abstract of the individual section see: 23117.

22864 (BMI-1704(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING NOVEMBER 1964. Russell W. Dayton and Stan J. Paprocki (Battelle Memorial Inst., Columbus, Ohio). Dec. 1, 1964. Contract W-7405-eng-92. 41p. Dep.; $1.00(CFSTI).

Progress is reported on the development of reactor materials and components, on radioisotope and radiation applications, on coated-particle fuel materials, on corrosion in fluoride-volatility processes, and on gas-cooled reactor development. (W.L.G.)

22865 (BMI-1711(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JANUARY 1965. Russell W. Dayton and Stan J. Paprocki (Battelle Memorial Inst., Columbus, Ohio). Feb. 1, 1965. Contract W-7405-eng-92. 45p. Dep.; $1.00(cy), 1(mn) CFSTI.

Progress is reported on development of reactor materials and components, reactor fuels development, radioisotope and radiation applications, coated-particle fuel materials development, and support work for the Army ML-1 program. (J.R.D.)

22866 (HW-81603) CERAMICS RESEARCH AND DEVELOPMENT OPERATION QUARTERLY REPORT, OCTOBER–DECEMBER 1964. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Contract AT(45-1)-1350. 80p. Dep.; $3.00(cy), 2(mn) CFSTI.

Progress is reported in sections on ceramic fuel research, irradiation behavior of ceramic fuels, PRTR fuel element fabrication and performance, joint fuel development programs, and development of advanced fuel concepts. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 22867, 22868, 22921, 23122, and 23123.

22867 (HW-81603(p.2.1-23)) CERAMIC FUEL RESEARCH STUDIES. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

No reaction was observed between PuO_2 and NiCr after heating a PuO_2–62 wt% NiCr pellet in pure H_2 for 12 hr at 1200°C. The thermal stability in air of PuO_2–62 wt% NiCr was superior to the UO_2–62 wt% NiCr. Stoichiometric amounts of Pu and Ag_2O were reacted in an attempt to form PuO. X-ray-diffraction analyses of the product showed α-Pu_2O_3, PuO_2, and Pu(O,N). X-ray-diffraction analyses indicate little or no composition range for beta Pu_2O_3 prepared by reacting stoichiometric beta Pu_2O_3 with 10% PuH_x and with 10% PuO_2 at 1450°C for 4 hr in high vacuum. PuN was prepared by the carbon reduction of PuO_2 under 600 mm of N_2. A single-phase (Pu,Zr)N was prepared by hydriding and subsequently nitriding a Pu–31.6 at.% Zr alloy. A fast reactor fuel material having satisfactory particle size and Pu distribution can be produced by dry ball-milling and impacting UO_2–PuO_2 powders. Recent electron microprobe analyses show that Pu is uniformly distributed throughout ball-milled, pneumatically impacted UO_2–PuO_2 mixtures. A technique for making "near-spherical" UO_2 particles from various angular and irregular UO_2 feeds by a tumbling treatment under controlled conditions was developed. Particles produced by this treatment are of suitable quality and strength for fabrication into cermets with little fracturing or stringering. UO_2 single crystals were characterized and shipped to ORNL, University of Michigan, and Northwestern University for research studies. A tentative O–U phase diagram in the range $UO_{2.16}$ to $UO_{1.78}$ was constructed from phase equilibrium and melting point studies in the temperature range 1800 to 2900°C. (auth)

22868 (HW-81603(p.4.1-12)) PRTR FUEL ELEMENT PERFORMANCE AND FABRICATION. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

The maximum burnup on packed particle ceramic fuel elements in PRTR as of December 31, 1964 is 2.07×10^{20} fissions/cm^2 (8260 Mwd/ton$_U$). A vibrationally compacted UO_2–2 wt % PuO_2 high power density element was successfully irradiated in the PRTR to a burnup of 0.4×10^{20} fissions/cm^3 (1470 Mwd/ton$_U$) at maximum fuel temperatures estimated to be near melting. There is no evidence of swelling, fuel washout, or water-logging of defected swage-compacted PRTR elements operating in the Fuel Element Rupture Test Facility. A cladding failure, probably caused by impurities in the fuel, was discovered in the bottom end cap region of a swage-compacted UO_2–0.5 wt % PuO_2 fuel element (FE-5185) during routine underwater examination following discharge from the reactor. Zircaloy-2 capsules were tested in a dry H_2 atmosphere. At lower temperatures (300 to 350°C) hydride attack is more likely to occur in the end cap crevice region, while at higher temperatures (350 to 400°C) hydride attack may occur anywhere along the capsule. The first five high power density PRTR fuel elements and four "standard" PRTR fuel elements were fabricated. Zircaloy-2 capsules were exposed to stresses of 1400 and 3800 atm in the presence of I_2 at 350°C. No cracking was observed after 4 days; but, pits 0.012 to 0.025 cm deep were found in areas of high stress. Operation of a 19-rod PRTR short-core element in the EDEL-1 loop caused only minor wear of the support pads and process tube after 500 hr at 280°C, 72 atm, and flows of 7.5 and 10.4 liters/sec. The feasibility of replacing single rods in irradiated fuel elements, such as a PRTR 19-rod cluster, was demonstrated. (auth)

22869 (HW-83298(p.5.1-38)) FUELS STUDIES. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Progress is reported in studies on Pu-B systems, preparation of β-Pu_2O_3, thorium nitride synthesis, electrolytic determination of water in Pu and U oxides, UO_2 electric conductivity, and microradiography. Development of techniques for use in fabrication of coextruded Zircaloy-2-clad Th–U fuel elements is discussed. Research on preparation and characterization of PuO_2 cermets is reported along with fabrication and evaluation of EBWR fuel. Fabrication methods development for small UO_2 rods, Al–Pu Phoenix fuels, and UO_2–PuO_2 fuels are reported. Results of PuO_2–UO_2 irradiation studies are included. Radiation effects studies are also reported on UN, PuN, US, and PuC. Studies of fission product behavior and radiation damage in UO_2 are reported. Data on PRTR fuel element development and performance are included. (J.R.D.)

22870 (HW-83601) PROGRESS IN PLUTONIUM UTILIZATION. A Summary of Hanford Laboratories Achievements in These Programs Under General Electric, 1956–1964. (General Electric Co. Richland, Wash. Hanford Atomic Products Operation). Dec. 1964. Contract AT (45-1)-1350. 209p. Dep.; $6.00(cy), 4(mn) CFSTI.

Research on fuel cycle analysis is reported in which physics and economic data were integrated, and computers were used to establish the optimum exposure value for Pu.

The value was determined as that which yields the same total fuel cycle costs as if ^{235}U only were used as the enrichment. In reactor physics studies, theory was developed for use in reliable engineering predictions of criticality and reactor reactivity when Pu-enriched fuels are used. Computational techniques were used in conjunction with demonstrations to evaluate Pu-fueled reactors. Reactor engineering development was devoted mostly to PRTR design. The employment of pressure tube construction in this reactor allowed flexibility in fuel irradiation and physics tests. Materials development efforts were devoted to Zircaloy-2. A successful process was developed for fabrication of tubing using Zircaloy-2. Testing and surveillance of Zircaloy-2 are reported. Technology associated with safe and economic fabrication of Pu fuels was developed. Fuel processing methods were developed for use in the Redox plant, and progress was reported in fuel recovery by the salt-cycle process. The PRTR was the major tool used in demonstrating the technical feasibility of Pu recycle. (J.R.D.)

22871 (ORNL-RMIC-3(Rev.)) GROUPS IV, V, AND VI TRANSITION METALS. SELECTED REFERENCES ON PREPARATION, STRUCTURE, PHYSICAL PROPERTIES, METALLOGRAPHY, AND TRANSPORT PROPERTIES. (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 97p.

Approximately 550 references are given to U. S. and foreign books, journals, and reports with special attention given to data compilations, special bibliographies and review papers published from 1956 through 1964. The references are divided under headings for preparation, crystal structure, transport properties, and physical and mechanical properties and subdivided into Group IV, V, and VI metals, (P.C.H.)

22872 (USBM-RC-1150) METALLURGICAL QUARTERLY PROGRESS REPORT NO. 25, OCTOBER 1–DECEMBER 31, 1964. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Contract AT(11-1)-599, 29p. Dep.; $2.00(cy), 1(mn) CFSTI.

Problems of porosity, internal cracks, and mold reactions were encountered in the casting of HfC. The evaluation of the casting quality and the results of the determination of the tensile properties at elevated temperatures, the emissivity, and the vaporization losses are reported. Two techniques for coating thoria spheres with thorium for the subsequent dispersion in a thorium matrix were studied. The first technique involves coating with an organic wax as a binder; the second technique utilizes the thermal decomposition of thorium iodide in a fluid bed. Investigation has continued on both the UC–UO and UN–UO binary systems. Considerable time was spent on the installation and performance testing of a new vacuum hot press, and on modifying the glove box to improve the purity of the inert atmosphere for powder and body handling. Precise determination of the limit of solubility of UO in UC has presented a difficult problem. Lattice parameters of the U(CO) phase continue to decrease as the nominal UO content is increased beyond 30 mole % in spite of a significant amount of free UO_2 remaining in the structure. Studies indicate a very low solubility of UO in the UN structure. Progress is reported in the W–Re tubing program and investigation of the engineering properties of W–25 Re alloys. (W.L.G.)

22873 (JPRS-28849) PROBLEMS OF THE THEORY AND USE OF RARE EARTH METALS. E. M. Savitskii and V. F. Terekhova, eds. Translation of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov," Science Publishing House, Moscow, 1964. 365p. (TT-65-30372; CONF-630301). $7.00(CFSTI).

A total of 46 papers are included which were presented at the Conference on New Trends in the Investigation and Use of Rare Earth Metals held at the Institute of Metallurgy imeni A. A. Baikov, Moscow, in March 1963. The papers cover new methods for the production of pure rare earths, physical properties of rare earth metals and alloys, phase diagrams, effects of rare earths on the plasticity of refractory metals, and the use of rare earths in the production of cast iron, steels, and alloys. Separate abstracts were prepared for 39 of the papers. (D.L.C.)

For abstracts of individual sections see: 22165, 22166, 22874, 22875, 22876, 22877, 22878, 22879, 22880, 22881, 22929, 22930, 22999, 23000, 23001, 23002, 23003, 23004, 23005, 23006, 23007, 23008, 23009, 23010, 23011, 23012, 23013, 23014, 23015, 23016, 23017, 23018, 23019, 23020, 23021, 23022, 23023, 23024, and 23025.

22874 (JPRS-28849(p.11-30)) WHAT'S NEW IN THE PRODUCTION AND USE OF THE RARE EARTH METALS. B. I. Kogan. Translated from p.15-29 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

A review is given of the rare earth metals from the economic standpoint since 1959. Raw material resources, mining and production, consumption, prices, applications, and research work are covered. (D.L.C.)

22875 (JPRS-28849(p.166-78)) INTERACTION OF VANADIUM WITH RARE EARTH METALS. Yu. M. Efimov, V. V. Baron, and E. M. Savitskii. Translated from p.129-37 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

Interstitial impurities (N, O, C, and S) and their effects on the properties of V are considered. The reactions of V with the rare earth metals and the types of phase diagrams are discussed. The deoxidation of V by the alloying additives and the subsequent effect on mechanical properties are shown. The refining of V by Ce was studied in detail. (D.L.C.)

22876 (JPRS-28849(p.227-33)) METALLOTHERMAL METHOD OF PRODUCING ALUMINIDES OF THE RARE EARTH METALS, THEIR PROPERTIES AND REGIONS OF APPLICATION. V. A. Podergin and G. V. Samsonov. Translated from p.172-6 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

A study was made of the aluminothermal reduction of La_2O_3, CeO_2, and Pr_6O_{11} in air (out-of-furnace) and in vacuum. Optimum conditions for the reduction were determined. The resulting alloys of La, Ce, and Pr with Al are discussed. (D.L.C.)

22877 (JPRS-28849(p.264-71)) NONMETALLIC INCLUSIONS IN STEELS WITH ADDITIONS OF RARE EARTH METALS. Yu. I. Rubenchik, Yu. V. Kryakovskii, E. I. Tyurin, E. P. Ponomareva, A. F. Vishkarev, and V. I. Yavoiskii. Translated from p.198-203 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

A study was made of oxide, sulfide, and oxysulfide inclusions in iron and construction steels, and the effect of rare earth alloying additions on these inclusions. In iron, Ce and La were found to form oxide and oxysulfide inclusions with a hardness lower than that of iron sulfide. The effects of rare earths on the corundum-base inclusions in the melting of steels were studied for the cases where the rare earths were added in the furnace, ladle, and trumpet in bottom casting. The effects of rolling on the inclusions were investigated also. The addition of rare earths in the trumpet resulted in the formation of flaws. (D.L.C.)

22878 (JPRS-28849(p.286-91)) INFLUENCE OF RARE EARTH METALS AND THEIR OXIDES ON THE PLASTICITY AND ANTICORROSION PROPERTIES OF STAINLESS STEELS. E. M. Savitskii, V. F. Popov, N. V. Keys, and V. N. Lyubimov. Translated from p.214-17 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

Improvement of the stainless steels Kh18N12M2T and 1Kh18N9T, whose ingots had been marred by surface blisters and eddies, was sought by the addition of 0.05-0.18% rare earth metals (REM) or 0.08-0.12% REM oxides (polyrite) under manufacturing conditions. The REM oxides were added into the ladle at temperatures of 1540–1570°C; the metal remained in the ladle for 10-15 minutes before being poured. Test specimens were evaluated for macrostructure, the content of alpha phase, corrosion resistance, and mechanical properties; plasticity was determined by the torsion test at high temperatures, and the size of the austenite grains was determined microscopically. The

additions were found to have a favorable effect on the technological properties of the 2 steels, resulting in an improved ingot surface due to better steel flowability, improved toughness, and disappearance of gross fissures at corners and planes of the bars, which reduced cleaning expenditure by 30–40%. Both the macrostructure and corrosion resistance improved, due to purification at the grain boundaries. Strength and plasticity increased while the anisotropy of the mechanical properties decreased. In the torsion tests at 1200°C, the number of rotations required for breaking increased from 10 to 24 and from 13 to 23, respectively. The addition of REM oxides rather than the pure metal or a metal mixture affords considerable savings in the modifier cost. The austenite grain was smaller in the Kh18N12M2T steel after oxide addition. The optimal additions found under these experimental conditions are given. (auth)

22879 (JPRS-28849(p.319-25)) INFLUENCE OF RARE EARTH METALS ON SOME PROPERTIES OF AUSTENITE CHROMIUM–NICKEL STEELS. N. S. Kreshchanovskii, M. F. Sidorenko, and A. S. Trekalo. Translated from p.238-42 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

A study was made of the influence of Ce, La, and Y on the plastic properties, impact ductility, and weldability of the cast austenite steel Kh15N25M3V3TYu. An addition of 0.5–0.1% Ce has a positive effect, while higher Ce contents result in a deterioration of these properties. The effects of Ce on the strengthening phases, inclusions, and dislocations are discussed. Y and La have an effect similar to but stronger than that of misch metal; they improve the plasticity and impact ductility without affecting the strength properties. (D.L.C.)

22880 (JPRS-28849(p.326-32)) USE OF CERIUM MODIFIER FOR THE PRODUCTION OF HIGH-STRENGTH CAST IRON. S. S. Zatulovskii, E. M. Nosova, E. S. Krylov, and A. A. Gorshkov. Translated from p.243-7 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The work conducted on the development of a technology for the production of cerium-cast iron with globular graphite is described. The processes of desulfuration and modification were combined, and smelting was carried out in an electric furnace and in a coke oven gas cupola furnace with a basic lining. The gradual introduction of the ferrocerium modifier under the stream during filling of the ladle and the mixing of the metal was found to be necessary for the production of a uniform cerium distribution. The dependence of the mechanical properties of the cast iron the carbon equivalent is shown, and the mechanical properties of preeutectic and posteutectic cast iron are compared. The effects of ferrosilicon addition after ferrocerium modification are discussed. The variables involved in the technology are discussed. (D.L.C.)

22881 (JPRS-28849(p.351-6)) PROPERTIES OF CRANKSHAFTS CAST FROM CERIUM CAST IRON. V. V. Zvolinskaya. Translated from p.261-6 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The advantages of the replacement of forged steel crankshafts by cast iron shafts are outlined. Experience with the casting and performance of cerium-modified cast iron shafts for tractor engines is reported. The mechanical properties of the shafts are described. (D.L.C.)

22882 HIGH TEMPERATURE FURNACE FOR X-RAY DIFFRACTION OF LIQUID METALS. M. L. Joshi (Yale Univ., New Haven). Rev. Sci. Instr., 36: 678-81(May 1965).

A high-temperature electric furnace (maximum temperature 1300°C) using pyrolitic graphite both as a heating element and as a crucible for x-ray diffraction of liquid metals is described. The usefulness of the furnace for high-temperature melting metals is demonstrated by obtaining an x-ray diffraction curve of molten copper in helium atmosphere. (auth)

22883 WERKSTOFFE DER KERNTECHNIK. TEIL I. (Materials of Nuclear Technology. Part I). Horst Scheibe, Horst Steinkopff, Irmtraud Quaeck, and Wilfried Huettig. Berlin, Veb Deutscher Verlag Der Wissenschaften, 1963. 231p.

The preparation, properties, and the radiation effects on reactor fuel materials (U, U alloys, U compounds, Pu, and Th) are reviewed and described. The book was designed to give a complete bibliographic review of the materials of nuclear technology in the German language. (537 references). (J.S.R.)

22884 WERKSTOFFE DER KERNTECHNIK. TEIL II. (Materials of Nuclear Technology. Part II). Harald Spindler, Heinz-Eberhard Roellig, Horst Steinkopff, Horst Scheibe, and Wilfried Huettig. Berlin, Veb. Deutscher Verlag Der Wissenschaften, 1964. 286p.

Literature on cladding materials and reactor fuel elements are reviewed. The latest applications of Zr, Be, Al, Mg, and their alloys and other fuel-element claddings are described. The technology of the fabrication and testing of reactor fuel elements is discussed. (525 references). (J.S.R.)

22885 WERKSTOFFE DER KERNTECHNIK. TEIL III. (Materials of Nuclear Technology. Part III). H. Flach, O. Hauser, M. Kittner, B. Koehler, F. Moldenhawer, F. Prokupek, H. E. Roellig, W. Schimmel, and H. Spindler. Berlin, Veb Deutscher Verlag Der Wissenschaften, 1963. 210p.

Literature on construction materials and processes, reactor coolants, moderators, and reflectors, and the properties and fabrication of control rods are reviewed. (320 references). (J.S.R.)

22886 THE PRODUCTION AND USES OF NATURAL GRAPHITE. A. R. Tron. London, Her Majesty's Stationery Office, 1964. 90p. 5s. 6d. (HMSO).

The preparation and uses of graphite are reviewed. Topics covered include: properties of graphite, mode of occurrence, industrial classification of graphite, geographical distribution, mining, beneficiation, consumer specifications, assessment of quality, uses of natural graphite, prices of natural graphite, and export duty and import tariffs. (M.C.G.)

22887 FORGEABLE CORROSION-RESISTANT AND NEUTRON ABSORBENT STEEL. (to Aktiebolaget Bofors). British Patent 980,759. Jan. 20, 1965. Priority date Dec. 8, 1962, Sweden.

Steel with good hot-working properties, good corrosion resistance, and a boron content of up to ~5% is described. The steel also contains a maximum of 0.15% C, 15–30% Cr, Ti ranging from a minimum wt % equal to 3.1% × (wt % of B) minus 5.8 to a maximum of 15%, a maximum of 2% Si, a maximum of 2% Mn, and normal contents of impurities such as P and S. (A.G.W.)

Corrosion

Refer also to abstracts 22665 and 23991.

22888 (AERE-R-4395) SIMULTANEOUS REACTION, DIFFUSION AND BULK FLOW IN TUBULAR SPECIMENS OF GRAPHITE. II. A CRITICAL EXAMINATION OF THE TRANSITION REGION. P. Hawtin and J. A. Gibson (Atomic Energy Research Establishment, Harwell (England)). Dec. 1963. 35p. Dep.(mn).

The variation with temperature of the oxidation rate of large tubular specimens of graphite exposed to air at the bore surface was examined. Evidence of a diffusional effect was obtained from gas concentrations in the tube bore and at its exterior surface. The effect of superimposed bulk flow of gas through the graphite on the observed oxidation rates was investigated. Good agreement between the observed results and those predicted from theory were obtained with pile A graphite at all temperatures within the transition region between chemical and diffusional control of the reaction. The simplified theory was extended to allow for a non-zero value of the CO/CO_2 ratio and for the concentration dependence of the diffusion coefficient. Under

the particular experimental conditions chosen for investigation, the effects of these factors are small. The effects on the calculated results of variations in the assumed order of reaction were investigated. The commonly assumed first order dependence of the graphite-oxygen reaction was found to be incorrect and support for a 0.6 order dependence obtained. (auth)

22889 (ANL-7006) CORROSION OF EXPERIMENTAL THORIUM-BASE ALLOYS. James Y. N. Wang (Argonne National Lab., Ill.). Feb. 1965. Contract W-31-109-eng-38. 12p. Dep.; $1.00(cy), 1(mn) CFSTI. .

Some 50 high-purity, binary and ternary, thorium-base alloys were prepared and corrosion-tested in distilled water between 120 and 260°C. During the relatively brief investigation, preliminary data indicated that the addition of titanium improved the corrosion life of Th–1 wt % and Th–0.5 wt % C binary alloys at 260°C. Additions of aluminum from 3 to 7 wt % appeared to be beneficial. At 200°C, a Th–10 wt % Y alloy exhibited a low corrosion rate during a short period of exposure. The corrosion resistance of all thorium–uranium alloys in increments of 5 wt % uranium, to the maximum 40 wt % uranium, was poor. The addition of 4 wt % zirconium to Th–15 wt % U caused an improvement at 200°C. (auth)

22890 (BNL-9018) A SUMMARY OF THE HIGH-TEMPERATURE ALKALI METAL CORROSION PROGRAM AT BROOKHAVEN NATIONAL LABORATORY. A. J. Romano, A. H. Fleitman, and C. J. Klamut (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 22p. (CONF-650411-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Joint NASA-AEC Liquid Metals Corrosion Meeting, Gatlinburg, Tenn.

Studies on the corrosion of refractory metals and their alloys in boiling-condensing Na up to 1315°C are reported. The alloys studied were Nb–Zr, Nb–W–Ta, Nb–W–Zr, and Ta–W. Sodium attack was not observed in any of the Nb–Zr capsules that were not exposed to oxygen. Although the addition of carbon to the Na did not cause corrosion of Nb–1 Zr, it did penetrate the grain boundaries to a depth of about 0.015 mm (½ mil). In other tests, the Nb–10 W–10 Ta was severely attacked intergranularly throughout the condensing region. Two alloys containing Nb–W–Zr were not attacked even after 8000 hr at 1260°C. Two Ta–10 W capsules containing refluxing Na were operated at 1266°C for 168 hr. Metallographic examination revealed extensive intergranular corrosion of the capsule. Details of the operating conditions and results are discussed. (P.C.H.)

22891 (CEND-525) INVESTIGATION OF CATALYTIC RECOMBINATION OF RADIOLYTIC OXYGEN AND HYDROGEN. Quarterly Report No. 5, October–December 1964. C. Thomas Sawyer and F. M. Stern (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Jan. 10, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-3151. 19p. (EURAEC-1330). Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

The endurance testing of catalysts is accomplished by taking 835–900 psig power plant steam, superheating it to the desired temperature, adding metered hydrogen and oxygen, passing the steam over the catalysts and monitoring the effluent for the remaining free oxygen. For parallel arrangement tests, 60 lb/hr of steam was passed through each of the catalysts. Several conditions existed in the catalyst beds during the tests. Data are tabulated. Because the use of the catalytic recombiner was successful in inhibiting chloride stress corrosion, tests were made on the effects of oxygen on intergranular corrosion. For these tests, stressed and sensitized Type 304 stainless steel specimens were exposed to 800°F, 860 psig steam. Two weeks of testing produced no intergranular cracks or attack in specimens located either upstream or downstream of the catalyst bed. Fourteen days of operation at 800°F, 835 psig, and 775 lb/hr without any injected chlorides also produced no intergranular cracks or attack. (P.C.H.)

22892 (DMIC-Memo-202) STRESS-CORROSION CRACKING OF ALUMINUM ALLOYS. J. D. Jackson and W. K. Boyd (Defense Metals Information Center, Battelle Memorial Inst., Columbus, Ohio). Feb. 15, 1965. Contract AF33(615)-1121. 13p.

Information on the susceptibility of aluminum alloys to stress-corrosion cracking is summarized. In general, the alloys most often associated with this problem in actual service are the 2014, 2024, 2219, 7075, 7079, and 7178 alloys in various heat treatments and the cast alloys of Ternalloy 7, 40E, 195, and 220. The major sources of stress that contribute to stress-corrosion cracking are either applied (as through press fits or fasteners) or residual (e.g., from heat treatment or machining). The prevention of stress-corrosion cracking requires basic knowledge of this phenomenon and of the relative resistance of the various alloys and of the effect of grain structure on the susceptibility to cracking. Application of this knowledge and the use of good practices in heat treatment, working, forming, machining, and design can help reduce the incidence of stress corrosion. In addition, the application of surface compressive stress (e.g., through shot peening) or the use of coatings also offers an effective means of minimizing or at least delaying stress cracking. (P.C.H.)

22893 (DP-957) STRESS CORROSION CRACKING OF AUSTENITIC STAINLESS STEEL. Status Report, September 1, 1964. McIntyre R. Louthan, Jr. (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.). Feb. 1965. Contract AT(07-2)-1. 20p. Dep.; $1.00(cy), 1(mn) CFSTI.

Stress corrosion cracking of austenitic stainless steel is being investigated to develop a fundamental understanding of the phenomenon. The status of studies relating specimen microstructure and dislocation substructure to the susceptibility to stress corrosion cracking are presented. The results show that anodic dissolution plays a major role in the nucleation and propagation of stress corrosion cracks. The susceptibilities of different heats of the same type of steel to cracking are quite different, and these differences are not attributable to differences in the composition of major alloying elements, material hardness or dislocation substructure. It is also shown that the relative rate of preferential attack at dislocation arrays and stacking faults in thin foils of type 304 stainless steel exposed to dilute NaCl solutions increased with increasing temperature and was more rapid in heats of steel which were most susceptible to cracking in bulk tests. (auth)

22894 (GEAP-4183) SODIUM MASS TRANSFER. VI. STATISTICAL CORRELATION OF 1961–1962 CORROSION DATA. E. L. Dunn (Vallecitos Atomic Lab., General Electric Co., San Jose, Calif.). July 1963. Contract AT (04-3)-189. 106p. Dep.(mn); $4.00(cy), 2(mn) CFSTI.

Statistical methods were employed to analyze weight change data of Type 316 stainless steel, 2¼Cr–1Mo, and 5Cr–½Mo–½Ti alloy steel samples exposed to sodium in six forced convection test loops constructed of various combinations of the test materials. The data collected prior to the end of December 1962 are reported and analyzed. The data treated represent approximately 60% of a five-run fractional replicate test plan being performed on five of the six test loops. This plan is based on evaluation of the effects of maximum temperature, ΔT in the system, and oxygen impurity level. In addition to the effects of the above primary test variables the effects of velocity, exposure time, sample temperature, and position in the test loop were evaluated for completed runs. Multiple regression methods were used in a three-step mathematical model to evaluate the test variables. The results are presented graphically and numerically to show the effects of the test variables on weight change. (auth)

22895 (HW-83298(p.9.1-3)) MATERIALS DEVELOPMENT, CORROSION, AND HEAT TRANSFER STUDIES. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Data on corrosion of Zircaloy-2 by water at 280°C are reported. Results are also reported on steam corrosion of

Hastelloy R-235, Inconel 702, and Hastelloy N at 649°C. Radiation effects on AISI 304 and 348 stainless steel and Hastelloy N at high temperatures are reported. Development and testing of PRTR pressure and process tubes are summarized. (J.R.D.)

22896 (MSAR-65-47) EFFECT OF HIGH TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report 55. (MSA Research Corp., Callery, Pa.). Apr. 13, 1965. Contract AT(11-1)-765. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The effects of high temperature sodium, and normally anticipated contaminants, upon the tensile, creep, creep-rupture, fatigue, and impact properties of Type 316 stainless steel and 2¼ Cr-1 Mo steel were investigated. Preliminary interpretations of the results indicate that carbon contamination in sodium will significantly reduce the fatigue life and the impact strengths, increase the rupture life, but reduce the ductility of 316 stainless steel. Results on 316 stainless steel in 1200°F, high (300 ppm) oxygen sodium indicate only a slight increase in the rupture strengths with a corresponding decrease in ductility. A slight decrease in the minimum creep rate was also observed. (P.C.H.)

22897 (TIM-655) TYPE 316 STAINLESS STEEL FORCED CONVECTION NaK CORROSION LOOP TESTS, NSSC-1A1, -2A2. M. J. Rieb (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). Apr. 28, 1961. Contract AT(30-1)-2789. 7p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

NaK was pumped through two loops constructed of type 316 stainless steel to determine the resistance of this material to corrosion and mass transfer at a maximum temperature of 1600°F. Post-test examination of these loops revealed the presence of mass transfer deposits to a maximum thickness of 1 mil. Carbide network and sigma phase formation were in evidence throughout the tubing from all sections of the subject loops. In addition and as a direct result of the sigma phase formation, intergranular oxidation to a depth of two mils was detected on the tubing OD surface. (auth)

22898 THE REACTIONS BETWEEN ZIRCONIUM AND CARBON DIOXIDE AT HIGH TEMPERATURE. Jean-Paul Guerlet and Pierre Lehr (CNRS, Vitry-sur-Seine, France). Compt. Rend., 260: 899-902(Jan. 18, 1965). (In French)

At high temperatures in non-renewed atmosphere, the oxidation of zirconium by carbon dioxide corresponds to a simultaneous diffusion of the carbon and the oxygen toward the metal through the surface film constituted by a mixture of monoclinic zirconia and a phase of oxycarbide type. (tr-auth)

22899 SUPERHEATED STEAM CORROSION OF ZIRCONIUM ALLOYS CONTAINING SMALL AMOUNTS OF IRON AND COPPER OR NICKEL. S. Greenberg and C. A. Youngdahl (Argonne National Lab., Ill.). Corrosion, 21: 113-24(Apr. 1965).

Alloys of zirconium containing small amounts of iron and copper or nickel had corrosion resistance in superheated steam superior to that of the Zircaloys. At 540°C (1004°F) and 600 psi lowest rates were about 4 mdd ($mg/dm^2/day$) (2.4 mpy ($mg/dm^2/yr$)) and at 650°C (1202°F) and 600 psi rates were about 6.8 mdd (4.1 mpy). High initial rates led to an extrapolated intercept of about 4 mg/cm^2 at 650°C (1202°F). The thickening films were subject to cracking at sharp radii. Absorption of corrosion product hydrogen decreased markedly as exposure temperature was raised from 540 to 650°C (1004 to 1202°F). This phenomenon was not understood. Metal embrittlement due to oxygen absorption became an increasingly serious problem as temperature was raised. The corrosion rate at 650°C (1202°F) was not affected by flow rate (300 ft/sec) or by presence of oxygen–hydrogen mixtures in the steam. (auth)

22900 CORROSION OF NIOBIUM AND TANTALUM IN ALKALINE MEDIA. I. I. Tingley and R. R. Rogers (Department of Mines and Technical Surveys, Ottawa). Corrosion, 21: 132-6(Apr. 1965).

Corrosion of niobium and tantalum in various alkaline media, at room temperature and at 208°F (98°C), was studied using both weight loss and electrical resistance methods. Media include aqueous solutions of alkali hydroxides, carbonates, phosphates, and sulfides. Embrittlement of the metal, nature of corrosion products, and methods of removing these products from the metal are briefly discussed. The metals appeared to be promising from the standpoint of corrosion resistance and embrittlement under some of the conditions investigated. Assistance of the potentiostat in determining the nature of niobium corrosion is determined. (auth)

22901 HYDROGEN UPTAKE OF ZIRCONIUM AND ITS ALLOYS DURING EARLY STAGES OF CORROSION IN STEAM. D. W. Freer, D. R. Silvester, and J. N. Wanklyn (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Corrosion, 21: 137-42(Apr. 1965). (AERE-R-4531)

Hydrogen uptake during initial stages of corrosion of zirconium and two zirconium alloys in steam at 500°C (932°F) and 1 atm is reported. Percentage uptake remained low down to the lowest weight gains examined (~1 mg/dm^2), suggesting that control of hydrogen entry resides in reactions at the oxide/steam interface. (auth)

22902 STUDIES ON THE OXYGEN GRADIENTS IN OXIDIZING METALS. III. KINETICS OF THE OXIDATION OF ZIRCONIUM AT HIGH TEMPERATURES. J. P. Pemsler (Kennecott Copper Corp., Lexington, Mass.). J. Electrochem. Soc., 112: 477-84(May 1965).

The oxidation of zirconium was studied in the temperature range from 840 to 1100°C. Film growth and oxygen solution processes were separated experimentally. Oxygen solution obeyed diffusion kinetics and remained parabolic for sufficiently thick samples. Film growth did not obey normal rate laws; an exceedingly rapid initial rate was followed by a period of slower growth. The overall weight gain curve is explained in terms of the separate film growth and oxygen solution processes. At temperatures ≥975°C voids formed in the oxide; they acted as diffusion blocks and promoted formation of a duplex layer. The mechanism of void formation is discussed in terms of a condensation of oxygen vacancies. The effects of orientation, pressure, surface preparation, and initiation temperature are discussed. (auth)

22903 CORROSION RESISTANCE OF LOW-CARBON ZIRCONIUM STEELS IN ACID AND ALKALINE MEDIA. V. S. Kovalenko and E. L. Yats. Mashinostroenie, No. 6, 54-5(Nov.-Dec. 1964).

Corrosion studies were made on a steel of the following composition (%): C = 0.16–0.21; Mn = 0.48–0.70; Si = 0.10–0.30; S = 0.031–0.042; P = 0.016–0.033; and Zr, up to 0.36. For acid media, HCl, H_2SO_4, and HNO_3 were used in various concentrations at various temperatures; the corrosion index was taken as the absolute or the relative loss in weight (average for three samples). It was established that the corrosion resistance of zirconium steels in a 20% aqueous solution of HCl or H_2SO_4 (under average conditions but with increased temperature) is significantly higher than that of carbon steel, and that the difference is apparent even at a content of 0.05% Zr. A steel with 0.33% Zr, tested in boiling 20% HCl, exhibited slightly more than 20% of the weight loss shown by steels without zirconium. Reduced weight losses, as compared with low-carbon steels, was characteristic in every instance with only a content of 0.04% Zr; high-zirconium steels tested in 20 and 30% HNO_3 exhibited lower corrosion resistance than low-carbon steels. The results of the tests in concentrated acids showed that zirconium steels retain their resistance superiority in concentrated HCl, which is non-oxidizing at any concentration, but low-carbon steels were more resistant in this case. The stability of the tested steels in concentrated H_2SO_4 and HNO_3 is practically identical; the presence of Zr was not a factor. To test alkali resistance, special samples with a zirconium content of 0–0.05–0.09–0.14–0.20–0.33–0.35% were placed in a boiling aqueous solution of 60% calcium nitrate and 4% ammonium nitrate, and examined every 10 hours. After 20 hours

cracks were observed in the case of steels with up to 0.14% Zr; in the case of steels with 0.33 and 0.36% Zr, cracks were observed after 40 hours. The cracks, as a rule, were formed in the boundaries of ferrite grains; each main crack had a number of branches along the boundaries of neighboring grains. It was concluded that zirconium strongly raises the corrosion resistance of carbon steels to cracking, the influence being exhibited even in the case of relatively small additions and proportional to its total content. (CFSTI)

22904 OXIDATION OF ZIRCONIUM IN CARBON DIOXIDE ATMOSPHERES. J.-P. Guerlet and P. Lehr. Mem. Sci. Rev. Met., 62: 151-62(Feb. 1965). (In French)

Carbon dioxide reactions with zirconium were studied between 600 and 850°C. Formation of a monoclinic zirconia surface film and dissolution of oxygen in the underlying metal were observed. CO_2 was reduced to CO. The output of CO_2 controlled the composition of the atmosphere. In the case of atmospheres rich in CO and when the temperature exceeded 1000°C, free carbon was deposited and zirconium carbide produced. (auth)

22905 GALVANOSTATIC STUDIES ON THE PASSIVITY OF STAINLESS STEELS OF THE 18 Cr–8 Ni TYPE. I. G. Murgulescu and Irina Cornea (Centre de Recherches de Chimie-Physique de l'Academie de la Republique Populaire Roumaine, Bucharest). Rev. Roumaine Chim., 9: 809-14(Dec. 1964). (In French)

The effect of the structural composition of the alloy on its tendency toward passivation was studied. Samples that have, for the same chemical composition, structures with variable proportions of the γ and δ phases were used for the study. With the aid of galvanostatic tests, the critical current time and intensity necessary for the complete passivation of the steel was established. The results given by tests in a medium of sulfuric acid, with or without the addition of NaCl, led to the conclusion that the presence of the δ ferrite has a favorable effect on the passivation capacity of the austenitic steel. (tr-auth)

22906 CORROSION-RESISTING FILMS PRODUCED ON TITANTIUM AND ZIRCONIUM IN HIGH TEMPERATURE WATER AND SEVERAL AQUEOUS CHLORIDE SOLUTIONS. Tadayuki Nakayama (Waseda Univ., Tokyo), Hiroyuki Yamada, Eiichi Yagi, and Junichi Yasui. Trans. Japan Inst. Metals, 5: 238-43(Oct. 1964).

Corrosion-resisting films produced on Ti and Zr surfaces in high-temperature water and several aqueous chloride solutions were studied using the electron microscopic and diffraction methods. The corrosion-resisting films produced on Ti in high-temperature water (200°C, 6 hr) consisted of rutile and anatase type TiO_2. The Zr plate was covered with monoclinic and cubic type ZrO_2 crystals with preferred orientations of {110} and {100} planes parallel to the metal surfaces, but these oriented films were not found on the cast specimens under the same condition. The protective films of Ti immersed in a boiling 10 or 28 wt % NaCl solution consisted of anatase or anatase and rutile, respectively. The surface films produced on Ti in artificial sea water and 10 wt % NaCl solution (200°C, 6 hr) were composed of rutile and anatase, and the surfaces were individually protected with rutile or α-Ti_2O_3 and rutile when the specimens were corroded in a high-temperature 20 or 28 wt % NaCl solution. The Zr plate dipped in artificial sea water, 10 ~ 28 wt % NaCl solutions (200°C, 6 hr), or boiling 10 wt % $AlCl_3$, $MgCl_2$, and NH_4Cl solutions were covered with the oriented ZrO_2 films. Rutile was found on the Ti surface dipped in the boiling 10 wt % $FeCl_3$ solution, while the film consisting of rutile and anatase was detected on the surface of Ti boiled in the 10 wt % $CuCl_2$ solution. However, the protective films produced on Ti in boiling 10 wt % $AlCl_3$, $MgCl_2$, and NH_4Cl solutions were composed of anatase. (auth)

22907 OXIDATION KINETICS IN ALLOYS OF TUNGSTEN–IRON AND TITANIUM–IRON SYSTEMS. R. F. Voytovich. Zh. Fiz. Khim., 39: 458-61(Feb. 1965). (In Russian)

A series of W–Fe and Ti–Fe alloys melted from 99.98% pure tungsten, 99.99% high-purity titanium, and carbonyl iron were tested for oxidation behavior at 500 to 900°C in air. The oxidation of W–Fe alloy at first increased sharply with increased Fe content and then dropped sharply at all test temperatures. Ti–Fe alloys follow a similar pattern. (ATD)

22908 ELECTROLYTIC SILICONIZING OF MOLYBDENUM IN FUSED SALT ELECTROLYTE. E. N. Shchetnikov, G. I. Belyayeva, N. G. Ilyushchenko, and I. L. Shchetnikova. Zh. Prikl. Khim., 38: 197-201(1965).

A study of electrolytic deposition of silicon on molybdenum for protecting the latter against oxidation was made. A dense and smooth 50-μ thick $MoSi_2$ coating was obtained from a fused-salt electrolyte consisting of 33% Na_2SiO_3 and 67% NaF, at 1100°C and 0.3 amp/cm^2 current density, in 4–6 hr. The coating protects molybdenum from oxidation at 1600°C for 7–10 hr, during which time the thickness of the coating increases almost 1.5 times and the composition changes to Mo_3S. (CFSTI)

22909 EFFECT OF IODINE ON THE REACTION OF GRAPHITE WITH CARBON DIOXIDE. T. Mukaibo and S. Yamauchi (Tokyo Univ.). Session VIII, Paper 2 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

The rate of the reaction of CO_2 with graphite containing more than 100 ppm vanadium decreased remarkably when iodine was introduced into the stream of CO_2. The rate did not return to its original value when the supply of iodine was stopped, and in some cases the rate was smaller than that during the time iodine was present in the CO_2. These effects were qualitatively reproducible, but not quantitatively. When iodine was introduced into a reaction system of CO_2 and graphite with less than 1 ppm of any metallic impurity, the reaction rate gradually increased to approach a constant value. The reproducibility of this value was good. (M.C.G.)

22910 OXIDATION OF PYROLYTIC GRAPHITE. Y. Tominaga and T. Nagaoki (Nippon Carbon Co., Ltd., Yokohama, Japan). Session VIII, Paper 4 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

Oxidation in pyrolytic graphite was studied as a function of temperature of oxidation and deposition. The oxidation was performed in air at 650 to 950°C. Oxidation rates and activation energies were determined for the basal planes and the edge planes of the pyrolytic graphites. Pyrolytic graphite annealed at 3200°C was oxidized faster at the edge than the basal plane by a factor of about 10. For pyrolytic graphite not annealed, oxidation proceeded preferentially on the edge plane at lower temperatures, but at higher temperatures the basal plane oxidized faster than the edge plane. Oxidation rates decreased with increasing deposition temperature. (M.C.G.)

22911 THE INFLUENCE OF SOLID CATALYSTS ON THE ETCHING OF GRAPHITE SINGLE CRYSTALS—A MOTION PICTURE STUDY. John M. Thomas (University Coll. of North Wales, Bangor, U. K.) and P. L. Walker, Jr. Session VIII, Paper 13 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 5p.

By using a 16-mm movie camera mounted on a microscope, it was possible to directly observe the oxidation of purified natural graphite single crystals. Oxidation of cleaved surfaces to which metallic impurities were added was also studied. The impurities included Fe, Ni, Co, Mn, Ta, Ti, Ag, Mo, and B. The catalytic effects of those impurities are described. (M.C.G.)

22912 THE INFLUENCE OF HUMIDITY ON THE OXIDATION KINETICS OF PURIFIED GRAPHITES. F. M. Lang and P. Magnier (Centre d'Etudes Nucleaires, Saclay, France). Session VIII, Paper 15 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

Experiments indicated that only in dry gas is the oxidation of carbon by air or oxygen very probably chemically controlled. The presence of moisture induced a strong positive catalysis, with the small pores becoming progressively backed. So long as this phenomenon continued,

the activation energy and the specific oxidation rate decreased. However, when oxidation began to take place only on the wall of the larger pores, conditions became homogeneous at this level. (M.C.G.)

22913 CORROSION RESISTANT BERYLLIUM ALLOY. Thomas Raine and James Alan Robinson (to Associated Electrical Industries Ltd.). German Patent 1,179,719. Oct. 15, 1964. Priority date June 27, 1961, Great Britain.

The corrosion resistant beryllium alloy described is (by weight) composed of 0.001 to 0.15% mercury and of 1 to 10% zinc, 0.5 to 5% copper, 0.1 to 2% manganese, 0.5 to 15% magnesium, 0.3 to 1.4% silicon, 0.5 to 2% calcium, 0.5 to 2% strontium, 0.1 to 0.5% iron, or 0.1 to 1% silver. The rest is beryllium. A combination of mercury with a plurality of the other elements is also possible. (Gmelin Inst.)

Fabrication

Refer also to abstracts 22968, 23123, and 24089.

22914 (AAEC/E-131) EXPERIMENTS IN EXTRUSION. PART 2. THE HOT EXTRUSION OF BERYLLIUM. W. J. Wright, J. M. Silver, and S. W. Spain (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1964. 38p. Dep.(mn).

A technique for the hot extrusion of beryllium powder within a mild steel sheath was developed. Limitations exist with this technique in the control of extruded dimensions, particularly on complex sections or where the sheath thickness is greater than about 0.020 inch. The use of preconsolidated powder billets is recommended to reduce the danger of the sheath buckling or splitting during extrusion and to improve the surface finish and dimensions of the product. Pick-up of oxygen and nitrogen by the beryllium was observed where the beryllium was not completely sealed from the atmosphere during heating and extrusion. This factor affected the mechanical properties of the material, particularly hardness. The mechanical properties of the sections were determined as a function of extrusion conditions, these properties are sensitive to the choice of extrusion temperature, presumably reflecting a tendency for residual work hardening to increase at the lower extrusion temperatures. (auth)

22915 (AERE-M-1314) THE FABRICATION OF $(UPu)O_2$–STAINLESS STEEL CERMETS FOR IRRADIATION. J. P. Evans (Atomic Energy Research Establishment, Harwell (England)). Feb. 1965. 25p. Dep.

The development and fabrication of cermet irradiation specimens are described. The cermets contained 30, 40, and 50 vol % $(U_{0.75}Pu_{0.25})O_2$ in Type 316L stainless steel. They were prepared by cold pressing and sintering or by hot pressing in order to study certain structural variables. The methods used are not typical of those that would be recommended at the present time. (auth)

22916 (BRB-80) QUARTERLY PROGRESS SUMMARY, OCTOBER TO DECEMBER 1963. (Bridgeport Brass Co., Seymour, Conn.). Mar. 27, 1964. Contract AT(30-1)-1405. 58p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

A cost study of U extrusion tooling to determine the areas for improvement was completed. A revision is mandrel specifications and new die materials are anticipated. A description of the extrusion press instrumentation is presented. Samples of Th metal produced from scrap material were evaluated for extrusion characteristics. A method was devised to salvage NPR ingots by machining off-specification billets to a smaller diameter. A summary of the process changes required to reduce the extrusion-warp in NIE primary extrusions is presented. The percentage rejections for warp was reduced from 50 to 5% as a result of the changes. The effect of varying the billet chamber angles or employing a radius does not appear significant on final extrusion results. Extrusion eccentricity appears primarily to be a function of billet diameter and eccentricity. A study to determine the dimensional changes during heat treatment of MARK V-B billets revealed that although the thickness of the heat treated billet wall changed, the wall thickness variation remained approximately constant. (auth)

22917 (CEA-R-2384) PURIFICATION PAR FUSION SOUS VIDE ELEVE ET SOLIDIFICATION PROGRESSIVE D'URANIUM D'ORIGINE ELECTROLYTIQUE. (Fusion Purification Under High Vacuum and Gradual Solidification of Electrolytic Uranium). Pierre Poeydomenge (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1964. 56p. Dep.(mn).

Thesis submitted to Paris Univ. (France). Faculté des Sciences.

Within the general framework of research on uranium purification by zone-melting, an attempt was made to determine the degree of purification that could be obtained by simple gradual solidification of a normal nuclear-pure uranium, paying close attention to the rate and direction of solidification. The uranium of intermediate purity would provide a starting material more suited to the final purification, which is a vertical zone-melting process, so-called floating. For this purpose, ingots of electrolytic uranium were melted under vacuum (2 to 5×10^{-6} mm) in a long UO_2 crucible after a slow rise in temperature to eliminate as much as possible the gases and volatile impurities. The degassing and impurity volatillization are completed by maintaining the liquid bath at a high temperature for a considerable time. The bath is then made to solidify from one end to the other of the crucible by slowly moving the solid-liquid interface at a constant rate to obtain an impurity distribution according to the laws established by PFANN. Various experimental methods made it possible to show that the metal that solidifies first is much purer than that at the other end of the ingot. The degree of purification of the metal at the beginning of the ingot was evaluated either quantitatively by measuring the ratio of the electrical resistivities at room temperature and at liquid nitrogen temperature, or qualitatively by an examination of the micrographic structure and by a study of the recrystallization of the metal. On the one hand the purified metal recrystallizes during isochronic annealings carried out at increasing temperatures, at a temperature much lower than the initial metal or than the end of the ingot. The passage from the cold-worked state to the recrystallized state is followed by microhardness measurements. On the other hand, only in the purified metal, strongly coldworked by unidirectional rolling, is the phenomenon of discontinuous growth of the grain observed, so-called secondary recrystallization. (auth)

22918 (EURAEC-1317) PREPARATION OF UO_2 POWDERS OF HIGH BULK DENSITY BY MELTING AND GRINDING AND THEIR PROCESSING INTO FUEL ELEMENTS. Quarterly Report No. 6, October 1–December 31, 1964. W. Duerrschnabel, B. Liebmann, O. Neumann, N. Mueller, P. Saalfeld, and L. Schikarski (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hanau am Main (West Germany)). Work Performed under United States–Euratom Joint Research and Development Program. Contract 013-63-7 TEED. 17p. (EUR-1800). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A total quantity of 560 kg of molten UO_2 from previous experiments was annealed in 100 kg batches in stoichiometric proportions at 1000°C in hydrogen. The O/U ratio obtained was about 2.008, for an annealing period of 5 hours the time required for one charge was about 24 hours/100 kg. An auxiliary graphite heating rod was used for preheating the substance. After sufficient preheating thereof, the rod was removed and the powder heated directly between the electrodes. Melting tests in air revealed that the nitrogen content of the UO_2 was not increased with respect to that obtained when melting in argon, and was comprised between 50 and 70 ppM. However, reduction of the uranium oxide by hydrogen during fusion was successful when fusion was carried out directly from powder. Extensive experiments were made for determining the influence of can dimensions and length of the powder column on the mean density and density variations. The results obtained for the average density were comprised between 87 and 89%. (P.C.H.)

22919 (EURAEC-1148) DEVELOPMENT OF PROCESSES FOR THE PREPARATION OF URANIUM CARBIDES AS WELL AS CERMETS ON A UC BASE. Final Report No. 3, July 1, 1962–June 30, 1964. P. Himmelstein, H. Kroll, H. Kuehn, B. Liebmann, and L. Schaefer (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hanau am Main (West Germany)). Work Performed under United States–Euratom Joint Research and Development Program. Contract 088-62-7/RDD. 63p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Pellets of UC of varying C contents were made by reaction of UO_2 with C in an induction furnace. Melting and casting experiments were carried out in a centrifugal furnace with graphite crucibles of various shapes. It was found that because of its flexibility the centrifugal method is suitable for the fabrication of samples for property tests and small-scale production, although only rods of low diameter (up to about 16 mm) could be cast without difficulty. If thicker rods were cast, cracks appeared and even pipes, in the case of rods over 27 mm in dia. The tests showed that the formation of pipes in the casting of UC rods is to a marked degree dependent on the casting speed. To test low casting speeds, melting and casting experiments were carried out in a tilting furnace. By slowly tilting the water-cooled Cu crucible long pipe-free rods with a dia. of >27 mm were cast. There was a tendency for cracks to form, and the surface was not smooth. In order to avoid these phenomena, the chills must be heated up to about 1,000°C before casting. A semicontinuous furnace with a pre-heated mold for the production of UC rods was constructed. Results of tests using the semicontinuous furnace showed that in production of UC in Cu crucibles, the melt quantity can be regulated by control of current distribution. This can be achieved by suitable shaping of the crucible, insulating between the rim and the bottom, and by the use of a magnetic centering field. Control of the Ar furnace atmosphere is helpful; it can be corrected by addition of CO. The casting of UC of up to 25 in dia. presented no great difficulties. Only a small portion of the rods showed cracks. This percentage increased considerably during casting when the rod dia was increased, conditions otherwise being the same, and decreased when slightly under-stoichiometric UC was cast. The UC samples fabricated for property tests were made into well-defined cylinders by circular-grinding, abrasive cutting-off and surface-grinding. A number of property tests were carried out on UC samples with C contents between 3 and 9 wt. %. They included chemical analyses of reacted pellets and cast rods, density determinations, and corrosion tests. Metallographic tests and the determination of impact strength and hot hardness provide an indication of the quality of these UC rods, fabricated in various skull-melting furnaces under different melting and casting conditions. The results of the thermal expansion, heat-conductivity, and electric conductivity measurements are within the range of the data given in the literature. (auth)

22920 (HW-70938(Del.)) AN ULTRASONIC WELDING PROCESS FOR ATTACHING ALUMINUM SUPPORT RAILS TO CYLINDRICAL ALUMINUM-CLAD HANFORD FUEL ELEMENTS. E. V. Padgett, Jr. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 5, 1961. Contract [AT(45-1)-1350]. 32p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Technical process developments required to apply the ultrasonic welding process to attachment of projections to Hanford aluminum-clad fuel elements are reported, and the design and operation of the automatic ultrasonic welding machine are given. (P.C.H.)

22921 (HW-81603(p.6.1-11)) DEVELOPMENT OF ADVANCED FUEL CONCEPTS. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

The enrichment of UO_2, in either pelletized or powder-packed form, with an axial Pu wire is being investigated to explore the use of both clad and unclad wires in fuel elements fabricated by swage compaction, vibrational compaction, and pellet processes. Peripheral enrichment of UO_2 pellets with UO_2–PuO_2 powder is being compared with Pu wire enrichment. An experimental fuel assembly was fabricated for in-reactor evaluation. Four capsules containing stainless steel–20 vol% PuO_2 cermet pellets were fabricated for irradiation in the MTR. Stainless steel clad, stainless steel–30 vol% UO_2 cermet fuel pins (0.210 in. OD × 36 in. long) were fabricated using a combination of pneumatic impaction and hot extrusion. Extrusion billets were prepared by pneumatic impaction and hot extrusion. Extrusion billets were prepared by pneumatic impaction, canned in heavy wall mild steel extrusion containers ($1\frac{1}{4}$ in. OD), and extruded at 1200 to 1250°C using a graphite sleeve for lubrication. A pneumatic impaction process for metallurgically bonding metal cladding and end caps to cermets while simultaneously densifying the cermet was demonstrated on a variety of metals. Several unique properties of the cermets and applications of the pneumatic impaction forming process were demonstrated in this study. With no observable distortion, thin-walled Al cladding supported low-density packed-particle fuel at pressures to 214 atm at room temperature. (auth)

22922 (HW-SA-3510) ESSENTIALS OF QUALITY CONTROL FOR PRODUCTION OF NUCLEAR WELDMENTS. E. B. LaVelle and D. L. Hovorka (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). [nd]. Contract [AT(45-1)-1350]. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Discussion is included on reliability, welding procedures, material identification, control of welding materials, high quality weld joint closures, dimensional tolerance, qualification of welders, supervision, design, and inspection and testing as essentials of quality control for production of nuclear weldments. (P.C.H.)

22923 (NMI-7004) STRUCTURES RESULTING FROM EXTRUSION OF URANIUM AT TEMPERATURES HIGH IN THE ALPHA PHASE. Report to E. I. du Pont de Nemours and Company. A. D. Donaldson (Nuclear Metals, Inc., Concord, Mass.). Oct. 19, 1960. Contract AT(30-1)-1565. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Uranium and uranium–0.16 wt % silicon rods were extruded at temperatures just below the alpha-to-beta transformation temperature. Under conditions of high speed and high reduction, rods were produced that had a random crystallographic orientation and the appearance of having transformed from the beta phase. In some cases, rods had this random structure surrounded by a rim of fine-grained material. (auth)

22924 (NMI-2135) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Monthly Progress Report, December 1964. (Nuclear Metals, (West Concord, Mass.)). Feb. 15, 1965. Contract AT(30-1)-2784. 27p. (NYO-2784-6). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Progress in establishing extrusion and drawing techniques for W–25 Re tubing is reported. Successful re-extrusions were obtained for 80-mil OD tubing from extruded stock that had received a recrystallization anneal. The drawn tubing is prone to crack, presumably because the roughly striated surfaces provide sites for stress concentration. Tests were made using material with surfaces conditioned to reduce the sharpness of the extrusion striations in an effort to determine whether such conditioning will inhibit cracking. The surface conditioning techniques and various drawing methods used are reported. Progress on the fundamentals of single-crystal deformation in zone-refined Be is also reported. (W.L.G.)

22925 (NYO-2784-8) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. Progress Report, February 1965. (Nuclear Metals, West Concord, Mass.). Apr. 8, 1965. Contract AT(30-1)-2784. 33p. (NMI-2137). Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Progress on development of extrusion and drawing steps for W–25 wt % Re tubing is reported. At the present stage of development, the drawing step in extrusion of $\frac{1}{4}$-in. OD × 20-mil-wall tubing requires major attention, and conditions of satisfactory re-extrusion for 80-mil × 8-mil-wall tubing are being sought. Research on single-crystal deformation in zone-refined Be is reported. The effects of Th additions are being investigated, and preparation of crystals with Fe + Si + Al additions is reported. (J.R.D.)

22926 (ORNL-TM-1047(p.109-12)) ORNL TARGET CENTER. E. H. Kobisk (Oak Ridge National Lab., Tenn.).

Functions of the ORNL Target Center are discussed. The techniques used in preparing targets are listed. Targets have been prepared of each element in the periodic table excluding the inert gases and a few of the man-made radioactive elements. Developmental efforts have been directed at improving the technique of vacuum evaporation of materials. Future emphasis is placed on the further development of techniques to reduce isotope cost and to improve target uniformity. (P.C.H.)

22927 (TIM-888) HIGH-TEMPERATURE THERMOMETRY AT CANEL. P. Bliss (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). Feb. 8, 1965. Contract AT(30-1)-2789. 21p. (CONF-650204-8). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Meeting on Thermocouple Technology and the Effects of Nuclear Radiation on Thermocouples, Washington, D. C.

The fabrication and performance of thermocouples from Chromel/Alumel, Nb, Zr, W, Re, and Mo for use at very high temperatures is reported. A thermocouple flow diagram is included. (P.C.H.)

22928 (WERL-8844-7) FEASIBILITY PROGRAM OF INERT GAS SHIELDED AUTOMATIC TUNGSTEN ARC WELDING 2" SCHEDULE 80 MONEL AND COPPER–NICKEL PIPE. F. J. Morley, Jr., A. T. Pucalik, and G. W. Norris (Westinghouse Electric Corp., Pittsburgh, Pa. Headquarters Mfg. Lab.). Dec. 1963. Contract NOBS-78844. 86p. Dep.(mn); $3.00(cy), 3(mn) CFSTI.

A program was pursued to determine feasibility of producing an automatic pipe welding machine to fit within prescribed outline dimensions. The desired ultimate application is to schedule 80 Monel and Copper-Nickel pipe in a horizontal and vertical fixed position. Using commercially available equipment in laboratory experiments on 2 in. pipe, suitable weld procedures were developed. Design layouts were developed to demonstrate that the essential equipment elements, with minor modifications, could be packaged to meet the requested space envelope. Controls to follow the welding procedure with minimum direct operator effect are described. (auth)

22929 (JPRS-28849(p.179-83)) INFLUENCE OF DEOXIDATION BY RARE EARTH METALS ON THE DEFORMABILITY OF MOLYBDENUM. E. M. Savitskii, V. V. Baron, and V. A. Frolov. Translated from p.138-40 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The dependence of the plasticity of bcc refractory metals on their purity is pointed out. The deoxidation of Mo was investigated using La, and it is shown that 0.15% La enables forging and rolling of Mo to be carried out at 700°. Lanthanum boride as a master alloy also worked well. (D.L.C.)

22930 (JPRS-28849(p.244-9)) INFLUENCE OF THE RARE EARTH METALS ON THE STRUCTURE AND MECHANICAL PROPERTIES OF THE SEAM METAL. T. M. Slutskaya. Translated from p.184-8 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The need of a welding method for producing high-quality seams without a protective medium is pointed out. A program for the development of wires for open-arc welding is described in which La, Ce, and ferrocerium were used as alloying additives. The properties of the resulting butt seams were studied, and optimum rare earth contents were derived. Two electrode wires were formulated on the basis of the results. (D.L.C.)

22931 (JPRS-29550) VACUUM DIFFUSION WELDING OF HIGH-WELDING METALLOID COMPOUNDS WITH HIGH-MELTING METALS. L. Ya. Popilov, ed. Translation of p.124-34 of "Novye Materialy v Mashinostroyenii," Leningrad, 1964. 12p. (TT-65-30713). $1.00(CFSTI).

The vacuum diffusion welding of carbides both with identical carbides and with high-melting metals was investigated. Tests were carried out on cylindrical samples with an end diameter of 6-8 mm and a height of 10-12 mm made from technically pure metals and from carbides having a composition close to stoichiometric and with a content of free carbon of up to 1% by weight. Welding was carried out in the temperature interval 1300-2000°C. The quality of the welded seam was controlled by means of metallographic investigation. The results showed the possibility of carrying out diffusion welding of the composition investigated at comparatively low temperatures and in conditions of low vacuum ($10^{-2} - 10^{-3}$ mm of Hg). (P.C.H.)

22932 CHARACTERISTIC PARAMETERS OF SINTERING AS MEASURES OF THE EFFECT OF COMPACTING PRESSURE ON THE SINTERING OF URANIUM DIOXIDE. M. M. Ristic, S. Radic, and B. Zivanovic. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 199-208(Oct. 1963).

An investigation was made of the effect of compacting pressure on the sintering of uranium dioxide as measured by changes in the characteristic magnitudes of sintering. It is shown that the density of a uranium dioxide compact changes with compacting pressure according to Rutkowski's equation. An analysis of the change of Lenel's densification parameter as a function of compacting pressure gave a good measure of the effect of compacting pressure on the sintering of uranium dioxide. From data for this characteristic quantity of sintering and Jander's equation, the effect of compacting pressure on the sintering rate is shown. In addition, it is shown how the pore shrinkage parameter changes with compacting pressure. (auth)

22933 CONSTRUCTION OF STAINLESS STEEL CLAD FUEL RODS BY Ni–P LAYER. Minoru Katsuta and Eiji Fukushima (Tokyo Shibaura Electric Co., Ltd.). Genshiryoku Kogyo, 10: No. 4, 53-6(Apr. 1964). (In Japanese)

A method is described of constructing stainless steel clad fuel rods using spacer rings which are plated with Ni–P alloy. The structures of binding were examined microscopically, chemically, and by mechanical testing. The structure is a mixture of solid solution of P in Ni and Ni–Ni_3P eutectic. The proeutectic Ni structure affects the binding strength. Data on micro-Vickers' hardness testing and tensile testing of the bindings are given, and an improved procedure of heat treatment is discussed. Corrosion tests in high-temperature and high-pressure water showed a weight loss of Ni–P plated spacer rings. The corrosion mechanism is not clear. (NSA of Japan)

22934 ON THE PROBLEM OF TANTALUM DEPOSITION FROM VAPOR-GAS PHASE. Ya. M. Polyakov and G. Z. Zamesova. Izv. Vysshikh Uchebn. Zavedenii, Tsvetn. Met., No. 4, 130-4(1964).

A series of experiments were performed in order to determine the basic conditions of the tantalum vapor deposition process. Tantalum pentachloride was evaporated into a stream of dry hydrogen and reduced to tantalum which condensed the outside surface of a nickel tube maintained at 650–1330°C. The thickness of deposits obtained varied with the temperature of the tube, and the deposition rates varied from 50 μ deposited in 40 min at 650°C to 250 μ deposited in 20 min at 1170°C. Deposits obtained at 650°C consisting only of tantalum were brittle and could be easily removed from the substrate. Deposits obtained at 800°C also contained tantalum hydrides, and those obtained at 900°C and above contained tantalum hydrides and a tantalum-nickel solid solution. The latter deposit adhered tightly to the substrate, forming a diffusion zone. Vacuum outgassing of deposits at 1800°C eliminated all of the gases and the nickel. The degassed deposits contained 0.409–0.715% impurities, including 0.2–0.5% niobium. (CFSTI)

22935 TANTALUM FILMS DEPOSITED BY ASYMMETRIC A-C SPUTTERING. F. Vratny and D. J. Harrington (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc., 112: 484-9(May 1965).

The technique of asymmetric a-c sputtering was evaluated for the deposition of tantalum films in argon, oxygen–argon, and nitrogen–argon gas mixtures. This method utilizes a lower sputtering potential on the tantalum substrate holder every half cycle compared to the potential on the tantalum cathode. At an optimum current ratio, tantalum films of three to five times that of bulk resistivity

were obtained compared to twenty to forty times bulk resistivity for normal d-c glow discharge sputtering. The reactive sputtering experiments confirmed that the normal high resistivity of sputtered tantalum films is caused by impurities gettered during the deposition and that the greater tolerance to reactive gas pressure with asymmetric a-c sputtering may be due to ion and electron bombardment during deposition. Further work is required to confirm this latter supposition. (auth)

22936 PREPARATION OF TRANSITION METAL OXIDE-METAL ELECTRODES. Richard L. Every (Continental Oil Co., Ponca City, Okla.). J. Electrochem. Soc., 112: 524-6(May 1965).

The fabrication of metal oxide–metal electrodes of ZrO_2, α-Nb_2O_5, Nb_2O_5(penta), Rh_2O_3, PdO, HfO_2, β-Ta_2O_5, Ta_2O_5(penta), and Pt on their respective parent metals is described. The molten oxidizing salts KNO_3 and $KClO_3$ were used with and without electrolysis. (M.C.G.)

22937 SOLID STATE WELDING OF REACTIVE AND REFRACTORY METALS. M. J. Albom. Mater. Design Eng., 61: 106-9(Apr. 1965).

The advantages of solid-state welding for joining reactive and refractory metals are discussed. In this method heat and pressure are applied simultaneously in a vacuum or protective atmosphere to produce coalescence of the base metals through interatomic diffusion, without fusion of the base metals or the use of intermediate filler metals. Examples of welding Be, Zr, W, Ti, Mo, Ta–W alloys, Nb alloys, stainless steel, Al–Ti–V alloys, Ni–Ti alloys, and Mo–0.5 Ti alloys by this method are given. Pretreatment methods are described. (M.C.G.)

22938 SOME OF THE FACETS OF POWDER METALLURGY IN RELATION TO NON-FISSILE MATERIALS IN NUCLEAR ENGINEERING. E. C. Macaluso and A. Perin (Centro Sperimentale Metallurgico, Genoa). Met. Ital., 57: 70-8(Feb. 1965). (In Italian)

Mechanical properties at high temperatures, thermal conductivity, magnetic properties, wear resistance, nuclear properties and radiation damage are shown to depend on the environment conditions during the operation of a nuclear reactor. These environment conditions characterize the metallurgical problems connected with the material used. In some cases it is therefore necessary, to employ the techniques of powder metallurgy because of the possibility of directly obtaining finished parts of complicated shapes in the case of materials difficult to be worked and shaped and of great purity and consequently of strict composition ranges. The limits within which the right interpretation of physical-chemical phenomena connected with the sintering process, allows the main properties to be made evident and makes it possible to choose the most convenient conditions, which show which one (or ones) of them is best for the actual condition of employment, are indicated. A few examples are given of the application of powder technology to materials for nuclear reactors in order to make clear how the sintering (which is the most important phase of the process) can affect the final properties required. (auth)

22939 ROLE OF THE SECOND-ORDER DISTORTIONS IN DENSIFICATION PROCESS DURING PRESSING, RECRYSTALLIZATION AND SINTERING OF REFRACTORY METALS. F. N. Alekseeva, R. S. Matyushenko, V. S. Rakovskii, and A. F. Silaev. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 5, 1-8(1964). (In Russian)

Powders of Mo, W, Nb, and Cr were compacted under pressure gradients from 1000 to 8000 dyne/cm^2 and sintered from 1200 to 1800°C. An x-ray analysis was made of the relationship between the applied pressure and resulting density of compacts and the second-order microdistortions (lattice polygonization). Effects of compacting pressure and lattice polygonization on the size of recrystallized grains in the process of sintering were studied. Use of the values of pressure and sintering temperatures to control the grain size of refractory compacts and hence their mechanical properties and creep is suggested. (Rev. Metal Lit., 22: (Feb. 1965))

22940 EXPERIMENT IN PRODUCTION AND GRANULARITY APPRAISAL OF THE COARSE TUNGSTEN POWDERS. L. I. Klyachko, M. P. Semenova, and N. K. Besolova. Poroshkovaya Met., Akad. Nauk. Ukr. SSR, No. 5, 77-80(1964). (In Russian)

Production of tungsten powder, 10 to 50 microns in dia., by reduction of ammonium paratungstate or of tungsten trioxide in a muffle furnace at 1200°C in hydrogen medium is described. Preparation of specimens for microscopic observation of powder granularity is also discussed. (Rev. Metal Lit., 22: (Feb. 1965))

22941 PRESSED-POWER SAMPLES FOR VERY LOW TEMPERATURE USE. R. I. Schermer and L. Passell (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr., 36: 709(May 1965). (BNL-8719)

Samples for low-temperature experiments were prepared by pressing a mixture of powdered electrical insulator and powdered metal in a die. The samples had excellent heat transfer properties, were uniform and homogeneous, and could be soldered. The preparation and properties of samples consisting of Pb and EuS and of Pb, zeolite, and Fe-Re alloy are described. (D.C.W.)

22942 PRODUCTION OF THORIUM METAL ON A PILOT SCALE AT TROMBAY. S. K. Kantan, N. K. Rao, and K. K. Sinha. Trans. Indian Inst. Metals, 17: 94-8(June 1964).

Processes for calciothermic reduction of ThO to produce Th are outlined together with methods for overcoming the pyrophoricity of the product. Powder fabrication techniques such as pressing, vacuum sintering, and machining are described. (Rev. Metal Lit., 22: (Feb. 1965))

22943 DIFFUSION KINETICS AFFECTING FORMATION OF SILICIDE COATINGS ON MOLYBDENUM AND TUNGSTEN. P. P. Gage and R. W. Bartlett (Philco Corp., Newport Beach, Calif.). Trans. Met. Soc. AIME, 233: 832-4(Apr. 1965).

The rate of formation of $MoSi_2$ and WSi_2 coatings was measured under conditions such that the silicide diffusion process is rate controlling and lower silicide compounds are not formed. A marker experiment using ZrO_2 was used to determine whether silicon or the respective refractory metals are the principal diffusion species in the disilicides. The temperature dependence of the rates of coating formation is shown. Silicon was found to readily diffuse in the marker, but diffusion of the refractory metals in their disilicides was not detected. (M.C.G.)

22944 INVESTIGATION OF THE BASIC FACTORS IN THE PROCESS OF COLD ROLLING NIOBIUM. A. V. Krupin, V. Ya. Solovev, V. N. Chernyshev, V. M. Isotov, and V. M. Korolev. Tsvetn. Metal., No. 12, 71-4(Dec. 1964).

The effects of degree of deformation for niobium during cold rolling at full and partial pressure, friction, torque, and forward flow, as well as the effects of the specimen width on the average specific pressure and widening were studied. Niobium, melted in a vacuum electric arc furnace with a consumable electrode, contained 0.05% C, 0.04% N_2, and 0.03% O_2. Rolling was done in a single pass with 5-80% deformation on a mill equipped with polished cast iron rollers measuring 210 mm in diameter. The average specific pressure of the metal on the rollers was calculated according to the measured total pressure and contact area determined with consideration of the elastic flattening of the rollers. A sharp increase in the specific pressure when $\epsilon \leq 20\%$ is explained by intensive hardening at a given compression interval: tensile strength was increased by 35%. The maximum value of the average specific pressure was observed during transition from natural to artificial bite and corresponds to the compression of $\epsilon = 20\%$ and bite angle $\alpha_b = 5.6°$. With further increase in compression, the specific pressure dropped reaching the tensile strength of cold worked metal when $\epsilon = 80\%$, where pressure was reduced by 16% in comparison from its maximum value. The decrease of the specific pressure at compressions above 20% is explained by the change in the system of the stress state during transition from natural to artificial bite, by

the appearance of longitudinal tensile stresses at the deformation site. It was noted that during rolling on rollers with a coarser surface, natural bite occurred in the studied compression range ($\alpha_b < \beta$); a maximum was not observed on the curves $p_{average} = f(\epsilon)$; and the specific pressure curve had an increasing character. In this case the usual system of the stressed state, uniform compression, occurred at the deformation site. Comparison of friction coefficient values determined by various methods indicated their slight deviation. The friction coefficient can be accepted as equal to 0.08-0.09 for practical calculations of stresses during cold rolling of niobium on polished rollers. To evaluate the experimental conditions and the possibility of using the obtained data under manufacturing conditions, the effects of the initial specimen width on the specific pressure and widening was investigated. Specimens with the initial widths of 10, 15, 20, 30, and 50 mm were rolled with compressions of 20% which corresponded to the maximum value of $p_{average}$. It was found that the initial width has an insignificant effect on the change of average pressure. (CFSTI)

22945 SEAM WELDING THE MA8 ALLOY. A. A. Chakalev, V. I. Zaitsev, G. F. Skakun, and Yu. V. Mel'nikov (Moscow Aviation Tech. Inst.). Welding Prod. (USSR) (English Transl.), No. 6, 30-5(June 1964). Translated from Svarochn. Proizv., No. 6, 16-19(1964).

The seam welding of MA8 (Ce–Mg–Mn) alloy sheet to produce vacuum-tight joints was investigated. (auth)

22946 THE VACUUM DIFFUSION WELDING OF CERTAIN REFRACTORY METALS. A. V. Krivoshei and N. F. Kazakov (Moscow City National Economy Council Scientific Research Lab. for Vacuum Diffusion Welding). Welding Prod. (USSR) (English Transl.), No. 7, 23-7(July 1964). Translated from Svarochn. Proizv., No. 7, 13-15(1964).

The possibility of welding tungsten, molybdenum, and niobium by the vacuum diffusion process with and without intermediate sheets was studied. The possibility of making these joints between porous refractory metals and dense metals, between metals with different coefficients of linear expansion, and between metals completely insoluble in one another is discussed. (auth)

22947 THE PRODUCTION OF SUPERCONDUCTIVE WIRE. Wire Ind., 31: 1096-7(Nov. 1964).

Fine superconducting wire was drawn from compacted Nb and Sn and placed within an inner Nb sheath and a Monel alloy 400 outer sheath acting as an electrical insulator. The range of wire sizes and typical tensile properties are discussed. Solenoid design and fabrication of magnets wound with the resulting wire and vacuum heat treated are described. Parameters of a typical magnet are listed. (Rev. Metal Lit., 22: (Feb. 1965))

22948 STUDIES ON THE WELDING OF THICK, HIGH TENSION STEEL PLATES USED IN NUCLEAR REACTORS. Hiroshi Kihara. Yosetsu Gijutsu, 12: No. 4, 62-9 (Apr. 1964). (In Japanese)

The purpose of the study was to compare the selected thick, high-tension steel plates in their welding properties to establish new automatic welding procedures, and to obtain the data for welding designs and procedures and for later inspections. The steel plates tested were four kinds of normalizing steel, HT60, and two kinds of tempering steel, HT70; the welding materials were coated arc-welding rods and electrode wires. The steel plates were 100 mm thick and had excellent high-temperature notch toughness. Tests made were as follows: (1) tests on the main materials, (2) experimental production of welding materials, (3) tests of the weldabilities, (4) tests of the welding procedures, and (5) tests of the joint properties. It was found that these materials could be used, to some extent, in pressure vessels for nuclear reactors at temperatures below 400°C. The use of these high-tension steels may thus make it possible to construct light, safe, and efficient reactors when suitable welding procedures are used. (NSA of Japan)

22949 DENDRITIC GROWTH OF TUNSTEN SINGLE CRYSTALS FROM THE VAPOR PHASE. Kuno Kirner (Robert Bosch GmbH, Stuttgart). Z. Metallk., 56: 179-82 (Mar. 1965). (In German)

The growth of dendritic tungsten crystals by a condensation process on tungsten cathodes of plasma burners is described. X-ray and metallographic techniques proved the [100]-direction to be the growth direction. (auth)

22950 AN INVESTIGATION OF THE GRAIN SIZE AND GRAIN SIZE DISTRIBUTION IN ZIRCONIUM POWDER. Guenter Weise (Institut fur Angewandte Physik der Reinstoffe, Dresden). Z. Metallk., 56: 186-96(Mar. 1965). (In German)

Zirconium powder was prepared by reduction of zirconium tetrachloride with sodium and/or magnesium in compressed forms in salt melts. The composition of the melts was varied from 50 to 100 wt % NaCl, 0 to 50 wt % $MgCl_2$, as well as 100 wt % $MgCl_2$. The temperatures were varied up to 900°C and the additions of reducing metal were varied. The average grain size was calculated from the number of (220) x-ray reflection spots and the size distribution from radial spot breadth analysis assuming a globular grain shape. The grain size increased with temperature and $MgCl_2$ content in the melt. The grain size dependence on the experimental conditions was analyzed qualitatively in terms of a homogeneous chemical reaction. (auth)

22951 FORGING BERYLLIUM FOR STRUCTURAL APPLICATIONS. J. A. Yoblin (Ladish Co., Cudahy, Wis.). 73p. (CONF-729-23).

From International Conference on Beryllium, Philadelphia, Oct. 1964.

The feasibility of ring rolling vacuum-hot-pressed beryllium was demonstrated. Triaxial forging of beryllium shafts, forging thin-walled beryllium pressure bottles, and the development and evaluation of techniques capable of producing aerospace-quality beryllium forgings are discussed. Figures are presented, which show forged beryllium structures. (M.C.G.)

22952 GRAIN SIZE EFFECTS IN POLYCRYSTALLINE CERAMICS. R. M. Spriggs, T. Vasilos, and L. A. Brissette (AVCO Corp., Wilmington, Mass.). 45p. (CONF-641116-3)

From Conference on the Role of Grain Boundaries and Surfaces in Ceramics, Raleigh, N. C.

The interrelation of pressure-sintering conditions in the graphite-die, ceramic-die, and ultrahigh pressure regimes, resulting microstructures, and mechanical properties are described, particularly for dense, pure, submicron and near-submicron grain size ceramic oxides, such as alumina and magnesia. Strength increases with decreasing grain size appeared to be limited by structural subtleties, which resulted from the processing techniques employed. Very-fine-grained, highly-dense ceramics, as initially prepared, had strengths, which were less than would be predicted on the basis of decreasing grain size. However, they responded to additional processing variations and post-fabrication treatments with changes in surface and interior structure and considerable relative strengthening. (auth)

22953 FLUORIDE TUNGSTEN. J. H. Oxley (Battelle Memorial Inst., Columbus, Ohio), E. A. Beidler, J. M. Blocher, Jr., C. J. Lyons, R. S. Park, and J. H. Pearson. 40p. (CONF-654-84)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

A thermodynamic and kinetic analysis of the hydrogen reduction of tungsten hexafluoride is presented, and a laboratory set-up to produce small quantities of the granular fluoride tungsten is described. The properties and purity of the produce are discussed. The granules can be consolidated into billets and rolled to sheet or pressed into final shapes. Some previously disclosed properties of the consolidated tungsten are reviewed and uses are suggested. (auth)

22954 METHOD OF PRODUCING TUBES OR RODS. (to Mitsubishi Atomic Power Industries, Inc. and Mitsubishi Denki Kabushiki-Kaisha). British Patent 981,065, Jan. 20, 1965. Priority date May 11, 1960, Japan.

An inexpensive method of producing a tube or rod of circular cross section composed essentially of Zr or Nb or both is patented. A metallic tubular member of circular cross section, or an annular space within it, is filled with powdered material of the desired composition and the ends of the assembly are closed. The assembly is then subjected to a swaging operation at a temperature between room temperature and 1000°C so as to sinter the mass of the powder to a high density, and the tubular member is removed by mechanical or chemical means. (A.G.W.)

22955 METHOD FOR THE PRODUCTION OF NUCLEAR FUEL CARBIDES. Kenneth Wallace Carley-Macauley and Gwilym Handel Williams (to Euratom). German Patent 1,181,187. Nov. 12, 1964. Priority date Nov. 29, 1960, Great Britain.

The method comprises the steps of producing a fine-grained powder of a nuclear fuel oxide and carbon, of adding a binding agent, of pressing the mixture, of granulating the pressed pieces, of heating the granulation to about 800°C to turn the binding agent into carbon, and of heating subsequently to about 2000°C to convert the oxide into carbide. (Gmelin Inst.)

22956 DEVICE FOR INTRODUCING GASES OR VAPOURS INTO A SALT MELT COVERED BY A PROTECTIVE GAS, PREFERENTIALLY FOR THE PRODUCTION OR RAFFINATION OF ZIRCONIUM AND OTHER HIGH MELTING METALS BY FUSION ELECTROLYSIS. Claude Pascaud (to Societe d'Electro-Chimie, d'Electro-Metallurgie et des Acieries Electriques d'Ugine). German Patent 1,186,639. Feb. 4, 1965. Priority date Apr. 28, 1961, France.

The device consists of an electrically heated tube, which is passed through a lock and a rotary valve disposed on the top of the crucible. A perforated basket, which dips into the melt, is attached to the lower end. (Gmelin Inst.)

22957 GRAPHITE DISPERSION. Marion Clifford Brockway (to U. S. Atomic Energy Commission). U. S. Patent 3,173,973. Mar. 16, 1965.

A method was developed for making a dispersion of oxide-coated particles in a graphite matrix by spraying the particles intermittently with a spray of solvent and a spray of a slurry of graphite in a solution of organic binder and organic liquid solvent in a rotating drum, removing the particles and pressing them isostatically in a pressing medium, removing the pressing medium, repeating the spraying and tumbling, pressing the particles uniaxially, and pressure baking the shaped dispersion. (AEC)

22958 METHOD FOR COATING ACTINIDE PARTICLES. John M. Blocher, Jr. and Melvin F. Browning (to U. S. Atomic Energy Commission). U. S. Patent 3,175,922. Mar. 30, 1965.

A process was developed for coating particles of actinide oxide with alumina, zirconia, or yttria by the decomposition of the chloride vapor in the presence of water vapor. A small quantity of chromia is codeposited by mixing chromyl chloride with the chloride–water vapor. (AEC)

22959 NITRIDED ELECTRODE PROCESS OF PREPARING URANIUM MONONITRIDE. Ellis L. Foster, Jr. and Roy W. Endebrock (to U. S. Atomic Energy Commission). U. S. Patent 3,178,259. Apr. 13. 1965.

A process was developed for producing uranium mononitride in an electric arc from a uranium cathode and nitrogen. The process is carried out in two steps, the first one using a low amperage to obtain only a skin of the nitride, and the second one using an increased amperage to convert the electrode to nitride throughout. (AEC)

22960 METHOD OF PREPARING SPHERICAL NUCLEAR FUEL PARTICLES. Howard E. Shoemaker (to U. S. Atomic Energy Commission). U. S. Patent 3,179,722. Apr. 20, 1965.

A method was developed of preparing dense spherical unagglomerated nuclear fuel particles. Particulate nuclear fuel and carbonizable binder containing an amount of carbon at least equal to the amount of nuclear fuel were mixed together and then particulated. The resulting particles of from about 300 to 500 μ size were dispersed in particulate graphite so that the fuel particles were out of contact with each other. The dispersion was then heated above the melting point of the nuclear fuel carbide and maintained at that temperature until the fuel particles melted and spheroidized. (AEC)

Properties and Structure

Refer also to abstracts 22462, 22914, 22919, 23164, 23355, 23956, 23958, and 23991.

22961 (AAEC/TM-274) THE CREEP OF BERYLLIUM OXIDE—A LITERATURE SURVEY. J. W. Kelly (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec. 1964. 13p. Dep.(mn).

High temperature creep properties of beryllia are reviewed and discussed in relation to the possible use of this material as the matrix of a dispersion-type fuel element. It is shown that the minimum creep rate ($\dot{\epsilon}$) probably follows a law of the form: $\dot{\epsilon}$ = constant × stress × exp (–110,000/RT) for unirradiated material. It is suggested that the creep rate is likely to increase under irradiation and that it is a sensitive function of porosity, decreasing markedly as the bulk density approaches its theoretical value. (auth)

22962 (AECL-2230) THE EFFECT OF UO_2 DENSITY ON FISSION PRODUCT GAS RELEASE AND SHEATH EXPANSION. M. J. F. Notley and J. R. MacEwan (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1965. 33p. Dep.(mn); $1.00(AECL)

The effect of UO_2 density on fission product gas release and sheath expansion was determined in an irradiation experiment in which the performance of fuel elements with densities between 10.42 and 10.74 g/cm^3 was compared at $\int\lambda d\theta$ values of 39 and 42 w/cm. The elements were irradiated as clusters of four in a pressurized water loop, hence their irradiation histories were identical. Fission product gas release and the extent of grain growth were greater for the lower density elements. Both effects can be attributed solely to the variation of the thermal conductivity of the fuel with the fractional porosity p, if $\lambda_p = \lambda[1 - (2.6 \pm 0.8)\,p]$ where λ is the thermal conductivity of fully dense UO_2 and λ_p is that of the porous UO_2. This expression is in agreement with laboratory findings. A correlation between the extent of grain growth in the UO_2 and the fractional gas release was found to exist in this test and was shown to apply in a large number of other fuel irradiations. Diametral sheath strain was lower for the low-density fuel elements than for those of high density, although the former were deduced to have operated with higher central temperatures. It is supposed that the thermal expansion of the fuel can be partially accommodated by elimination of some of the original porosity. The data are consistent with the assumption that approximately half the porosity in the region of the fuel undergoing grain growth is eliminated. (auth)

22963 (AEET/CD/33) STUDIES OF THE ELECTRICAL PROPERTIES OF URANIUM OXIDES. IV. NON-STOICHIOMETRIC U_3O_8. Nirmal Singh and M. D. Karkhanavala (Atomic Energy Establishment, Trombay (India). Chemistry Div.). 1964. 31p. Dep.(mn).

The d-c electrical conductivity (σ) and the Hall coefficient (R_H) were measured in the range 250 to 400°K on pellets of U_3O_8 sintered for different periods (up to 120 hours) at 900°C, resulting in a variation of the O/U ratio from 2.666 to 2.63 and an increase in the density from a green density of 5.62 to 8.08 g/cm^3. With increase in the time of sintering, the conductivity and Hall mobility increased, while the activation energy of conduction decreased. The results on the highly sintered (96.5% theoretical density) pellet of composition $UO_{2.63}$ were interpreted on the basis of hopping of small polarons. (auth)

22964 (AERE-R-4487) POINT DEFECTS IN URANIUM OXIDES. B. T. M. Willis (Atomic Energy Research Establishment, Harwell (England)). Dec. 1963. 20p. Dep.(mn).

Neutron diffraction measurements on single crystals of uranium oxides, with compositions in the range $UO_{2.00}$ to $UO_{2.25}$, led to an identification of the types of point defects arising from the departure from stoichiometry. Interstial oxygen atoms enter the UO_2 lattice at two kinds of site, which are displaced by about 1Å along ⟨110⟩ and along ⟨111⟩ from the holes at the $\frac{1}{2}\,\frac{1}{2}\,\frac{1}{2}$, $\frac{1}{2}00$, $00\frac{1}{2}$ positions. The solution of oxygen is accompanied by the formation of vacancies in the normal oxygen sub-lattice, but the uranium sub-lattice remains undisturbed. It is probable that the oxygen interstitials and vacancies are associated together as defect complexes; at the limiting composition of $UO_{2.25}$ these complexes are ordered to form a cubic phase based on the fluorite arrangement but with an enlarged unit cell. (auth)

22965 (AL-TDR-64-239) STUDY OF SEMICONDUCTING PROPERTIES OF SELECTED RARE-EARTH METALS AND COMPOUNDS. J. F. Miller, F. J. Reid, L. K. Matson, J. W. Moody, R. D. Baxter, and R. C. Himes (Battelle Memorial Inst., Columbus, Ohio). Feb. 1, 1964. Contract AF33(657)-10687. 90p. (AD-607082). $3.00 (CFSTI).

Studies were made on the compounding, crystal growth, characterization, and evaluation of compounds formed between the rare earth elements and elements of chemical Groups V and VI. Special emphasis was placed on providing basic information to make possible the ultimate development of useful solid-state electronic devices based on these materials. In sampling the members of the rare earth family, the elements cerium, neodymium, samarium, gadolinium, erbium, and ytterbium were used in the preparation of representative compounds and alloys with anions, such as, selenium, tellurium, oxygen, arsenic, antimony, phosphorus, and nitrogen. Single crystal, bulk, and thin-film specimens were prepared, and details regarding methods of compounding and crystal growth are given. Crystal structure and phase relations indicate that, in some cases, as many as four distinct crystalline phases may exist within a single binary system. While electrical conductivities in the materials treated fall generally in the semiconductor range, transport mechanisms are not entirely consistent with classical semiconductor theory. The electrical properties of specimens of the various compounds and compositions are consistent, in general, with the present understanding of the chemistry and crystal structure of the rare-earth elements and compounds. Several applications of rare-earth compounds and alloys studied are suggested. (P.C.H.)

22966 (BNWL-8) STRESS RUPTURE TESTS OF ZIRCALOY-2 PRESSURE TUBES. R. C. Aungst (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1965. Contract AT(45-1)-1830. 30p. Dep.; $2.00(cy), 1(mn) CFSTI.

Zircaloy-2 pressure tubes were subjected to creep and stress rupture tests under conditions of biaxial stress at temperatures of 300°C and higher. Comparison with uniaxial tests on strip shows that tubing requires 60% higher stresses for comparable creep rates. Stress rupture tests indicate 20 yr life for the tubing at stresses more than four times the design stress for the reactor. Initial tests on irradiated tubing show about 5% improvement in creep strength resulting from 3 yr exposure in a production reactor. (auth)

22967 (COO-1198-161) EFFECTS OF ELECTRODEPOSITED COATINGS ON THE DEFORMATION OF COPPER CRYSTALS. R. J. Block and M. Metzger (Illinois Univ., Urbana). [1963]. Contract [AT(11-1)-1198]. 38p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Tensile stress-strain parameters were measured for copper crystals of a particular orientation with electroplated 0.1–3 μ chromium coatings. With increasing coating thickness, the critical shear stress and the rate of strain hardening in easy glide showed a continuous increase while the maximum strain in easy glide decreased sharply. The decrease in extent of easy glide indicated that the presence of the coating had altered the behavior of the underlying crystal and produced what was termed an interaction hardening. The interaction hardening persisted after the coating had cracked and had therefore lost its influence on the crystal. The magnitudes of the coating strength and the interaction hardening at small strains were determined from the flow stress differences in interrupted tests in which the specimen was extended in increments alternately in the coated and uncoated condition. The existence of the interaction hardening was further indicated in etch-pitting studies, which showed higher dislocation densities through the crystal for a coated crystal at a given strain. The interaction hardening was considered to originate from the action of the coating at small strains as a translucent barrier to the egress of dislocations from the crystal. (P.C.H.)

22968 (DMIC-Memo-200) SUMMARY OF THE NINTH MEETING OF THE REFRACTORY COMPOSITES WORKING GROUP. E. S. Bartlett and H. R. Ogden (Defense Metals Information Center, Battelle Memorial Inst., Columbus, Ohio). Mar. 3, 1965. Contract AF33(615)-1121. 18p.

Information on refractory materials and composites as presented at the meeting is summarized. A wide variety of subjects ranging from basic studies on oxidation mechanisms to the development of specific pieces of hardware was included in the 49 papers presented. The papers are reviewed and discussed briefly within the framework of four broad areas: materials technology; process technology; specific hardware applications; and evaluation techniques. Bulk refractory materials and coated-metal systems are included in the section on materials technology. Hot spraying, chemical vapor deposition, powder processes, and joining are discussed in process technology. The specific hardware applications cover rocket-motor components, nose caps, leading edges, and hot skins. (P.C.H.)

22969 (DPSPU-65-30-18) METALLOGRAPHIC EXAMINATION OF HIGHLY ALPHA-CONTAMINATING MATERIALS. G. A. McCaskey (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Plant). Mar. 1965. Contract AT(07-2)-1. 14p. (CONF-650414-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From 19th Metallographic Group Meeting, Oak Ridge, Tenn.

Techniques were developed to examine metallographically transuranium–aluminum alloys and other metal alloys contaminated with up to 2×10^9 d/m alpha activity, in a "clean" laboratory area. Metallographic specimens are prepared in a glove box and then removed in plastic bags containing 0.004-inch-thick polyvinyl chloride windows wetted on the inside and outside surfaces with immersion oil. By aligning the specimens in the windows, metallographic examinations and photomicrographs of microstructures can be made at magnifications up to 1500×. (auth)

22970 (DPST-65-83-2(p.8-12)) HYDRIDE ORIENTATION AND MECHANICAL PROPERTIES OF THIN-WALLED ZIRCALOY TUBING. R. P. Marshall (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.).

Studies of factors that influence the orientation of zirconium hydride platelets in thin-walled zircaloy tubing are outlined. Analysis of tensile data showed that hydrides reduce the macroscopic ductility of zircaloy by a strain concentration mechanism. During strain the hydride platelets and clusters act as discontinuites in an otherwise continuous matrix, thereby restricting the strain into bands and causing highly localized strain. Fracture of the zircaloy occurs when the critical (fracture strain) is reached in and occurs through the strain band. The hydride platelets and clusters influence strain concentration and thus provide the basis for relating hydride morphology to macroscopic fracture ductility. (C.E.S.)

22971 (DRI-1092-201) DETERMINATION OF PHASE EQUILIBRIA IN THE SYSTEM $BeO-ThO_2$. Second Quarterly Report. Henry E. Otto (Denver Research Inst., Univ. of Denver, Colo.). Mar. 15, 1965. Contract AT(11-1)-1092. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Studies of the BeO–ThO_2 system indicate that eutectic reaction occurs between 70 and 74 mole percent BeO at a temperature of about 2150°C. The limits of solid solubility of BeO in ThO_2 at 2760°C as indicated by ceramographic inspection is less than 1.0 mole percent BeO. Solid solubility studies of ThO_2 in BeO at temperatures in excess of 2300°C indicate that the extent of solid solubility is less than 0.25 mole percent ThO_2. (auth)

22972 (DRI-1092-202) PHASE EQUILIBRIA OF THE TANTALUM-RICH REGION OF THE TANTALUM–TUNGSTEN–HAFNIUM AND TANTALUM–TUNGSTEN–ZIRCONIUM SYSTEMS. Quarterly Progress Report No. 2. Donald T. Klodt and Albert S. Yamamoto (Denver Research Inst., Univ. of Denver, Colo.). Mar. 1965. Contract AT(11-1)-1902. 7p. Dep.(mn); $1.00(cy), 1(mn). CFSTI.

The solid-state phase equilibria at 1600, 1300, and 1100°C are being determined for the tantalum-rich regions of the Ta–W–Hf and Ta–W–Zr alloy systems. Alloys for the investigation are prepared by arc melting charges consisting of a 60 wt % Ta–40 wt % master alloy with appropriate additions of tantalum and hafnium or tantalum and zirconium. The as-cast alloys are homogenized by means of a high-temperature heat treatment in vacuo prior to the vacuum annealing treatments at the three isothermal levels. Metallographic examination of the annealed structures and x-ray-diffraction studies of the alloys are the principal techniques employed to determine the phase equilibria. The results of the metallographic examination of as-cast alloy structures are summarized and a discussion of the high-temperature vacuum annealing furnace and the annealing procedures used are presented. (auth)

22973 (DRI-1092-203) STUDIES OF THE EFFECT OF INTERSTITIAL ADDITION ON THE PHASE EQUILIBRIA OF THE NIOBIUM-RICH REGION OF THE NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM ALLOY SYSTEMS. Quarterly Progress Report No. 2. Albert S. Yamamoto (Denver Research Inst., Univ. of Denver, Colo.). Mar. 1965. Contract AT(11-1)-1092. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Investigation of the effect of carbon and oxygen additions on the phase relationships of the niobium-rich region of the niobium-tungsten-hafnium and niobium-tungsten-zirconium alloy systems is in progress. Isothermal annealing at 1600 and 1300°C (2912 and 2372°F) of a first series of the niobium-tungsten-hafnium with nominal carbon additions of 0.5, 0.25, 0.1 and 0.05 wt % were completed. Preliminary microscopic examination showed that precipitation of a second phase or phases has occurred in all the annealed alloys. A limited number of the niobium-tungsten-zirconium alloys containing nominal 0.25, 0.1 and 0.05 wt % C was heat treated at 1600°C (2912°F). Again all the alloys examined metallographically exhibit the structures with a varying degree of precipitation of a second phase. In both niobium-tungsten-hafnium and niobium-tungsten-zirconium alloy systems, an additional series of selected alloys of nominal 0.01 wt % C will be prepared. Arc-melting of the niobium-oxygen master alloys is nearly completed. Tentative selection of the oxygen additions to these two alloy systems is described. (auth)

22974 (EURAEC-1275) STUDY OF ELEMENTARY CRACKING. PRELIMINARY QUALIFICATION STUDY OF WELDING PROCEDURE. Quarterly Report No. 8, October 1–December 31, 1964. (Institut de Soudure, Paris (France)). Feb. 12, 1965. Work Performed Under United States–Euratom Joint Research and Development Program. Contract 090-62-12 RDF. 9p. (EUR-2082). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

For the purpose of defining the method of operation, mechanical tests and examinations on molten metal were proceeded with on the assemblies (MIG process and submerged-arc welding) of AMMO steel coupons, 420 × 400 × 95 mm. As well as the molten metal analysis of each assembly, the following tests were carried out: tensile test on transversal prismatic test-pieces; tensile test on longitudinal and transversal cylindrical test-pieces; lateral bending; notch impact strength at half and quarter thickness (resilience/temperature curves); Pellini tests on cutting; and metallographic examination. With the electrode wires and welding conditions used in these tests, the results show that submerged-arc welding is definitely more advantageous as regards the impact-strength transition temperature. The Pellini test on transversal cuttings at right angles to the plate skin yielded disappointing results; the fact that the elastic limit of the molten metal is higher than that of the base metal limits the deformation of the molten metal under the notch and transfers it to the base metal. This makes the transition temperature (NDT) values illusory. (auth)

22975 (EURAEC-1314) DIFFUSION OF RARE GASES IN SOLIDS. 18th Quarterly Report, October–December 1964. (Hahn-Meitner-Institut für Kernforschung, Berlin (West Germany)). Jan. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract 028-64-1 TEE (RD). 23p. (EU-B37). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A collection of magnitudes that is used for evaluating ideal volumetric diffusion is given. Studies on sintered UO_2 powder showed that the initial burst that occurs in PAD tests is possibly due to the release of recoil-induced atoms. With reference to an experiment on Xe diffusion from a UO_2 single crystal sphere, an initial example is given for the calculation of the diffusion fraction from the rare gas release when the fraction liberated by evaporation of the sample cannot be more than twice the diffusion fraction. In the case of ^{41}Ar and ^{39}Ar diffusion in KF it was found that: $D = 7.7 \times 10' \exp(-40400/RT)$ at 350–800°C. In the case of tritium diffusion in an Ag–Li alloy under neutron bombardment it was found that: $D = 1.05 \times 10^{-2} \exp(-11500/RT)$ at 300–550°C. (auth)

22976 (GA-4901) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending December 31, 1963. R. J. Price and J. L. White (General Atomic, San Diego, Calif.). Mar. 16, 1964. Contract AT(04-3)-167. 46p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

Progress in the investigation of the microstructure of graphite is reported. Three different experimental approaches are used. The microstructure is being characterized through quantitative sensitive-tint microscopy and analysis of the fracture characteristics. Exploration of the variables of and fracture conditions during hot-working and the recrystallization from liquid nickel is being conducted as a means to modify the microstructure of graphite. The relation of the physical properties of the microstructure is being studied by an analysis of the preferred orientation and thermal expansion, the residual stresses in an extruded graphite tube, preferred orientation and Young's modulus, preferred orientation and radiation-induced dimensional changes, and high-temperature deformation mechanisms. (W.L.G.)

22977 (GA-6163) A PROGRAM OF BASIC RESEARCH ON MECHANICAL PROPERTIES OF REACTOR MATERIALS. Quarterly Progress Report for the Period Ending January 31, 1965. J. C. Appel, R. H. Chambers, and T. A. Trozera (General Atomic, San Diego, Calif.). Feb. 25, 1965. Contract AT(04-3)-167. 28p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Progress in a method to relate the potential-drop resistivity of tungsten single-crystals to the impurity content is reported. A relation between the ratio of the resistivities at 4.2 and 273°K and the impurities content is developed which eliminates the other factors contributing to the resistivity at low temperatures. The dislocation relaxation structures of Fe, Nb, Ta, and W are determined by applying a new method for the measurement of the mechanical-strain relaxation. This method enables the true stress-dislocation strain curve to be determined. Dislocation relaxations are separated into two components, and the contributing dislocation types are tentatively assigned. Edge and edge-screw dislocations are associated with low-temperature relaxations and screw dislocations with high-temperature relaxations. (W.L.G.)

22978 (HW-SA-3481) THE KINETICS OF SOLID-STATE ELECTRODIFFUSION OF SOME TRANSITION

ELEMENTS IN GAMMA-CERIUM, GAMMA-URANIUM, AND EPSILON-PLUTONIUM. R. H. Moore, F. M. Smith, and J. R. Morrey (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). May 11, 1964. Contract AT(45-1)-1350. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Quantitative measurements of the electrodiffusion rates of iron, cobalt, nickel, and copper in γ-cerium and of iron in γ-uranium and ε-plutonium were made. Within experimental error, the electrodiffusion rates of iron and cobalt in γ-cerium are proportional to the potential gradient and independent of temperature in the range 495–650°C. Using the diffusional theory of Eyring, suitably modified for these systems, activation energies were calculated that agree well with the observed values. These results indicate that electrodiffusion in cerium is predominately via grain boundaries. In γ-uranium and ε-plutonium the data and calculated activation energies for electrodiffusion of iron are also inconsistent with a mechanism of volume diffusion. Iron may diffuse interstitially in these metals. (auth)

22979 (IDO-17006) DIFFUSION IN STABILIZED ZIRCONIA–URANIA SYSTEM. D. R. Mash and K. K. Ikeuye—Reese S. Kern, ed. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1964. Contract AT(10-1)-205. 39p. Dep.; $2.00(cy), 1(mn) CFSTI.

Diffusion in the stabilized zirconia-urania system was investigated by the moving boundary (metallographic) technique with the objective of measuring penetration of zirconia cladding by urania at elevated temperatures. Natural UO_2 cored pellets were coated by the plasma-spray technique. Uniform coatings of about 89% of theoretical density were applied using carefully controlled process conditions. Diffusion annealing treatments were carried out in the 2000 to 2450°C range for 8-hour periods in helium. Diffusion zone characteristics, observed metallographically, provided evidence of relatively complicated interactions taking place in this ternary system at temperatures close to the melting point of the coating. The ZrO_2–UO_2 interface region after diffusion included a void zone, a ternary solid solution zone, the moving boundary, and a high density zirconia-rich zone. A penetration coefficient, K, which is proportional to the diffusion coefficient, was measured as a function of temperature and the results were correlated by means of the usual rate equation. Based on the results, it was concluded that diffusion in the stabilized ZrO_2–UO_2 system is strongly temperature dependent; however, even at temperatures close to the melting point of zirconia, uranium would not completely penetrate a 0.050-inch coating after eight hours. (P.C.H.)

22980 (IS-T-7) THE EFFECT OF STRAIN RATE AND TEMPERATURE ON THE DUCTILITY OF PURE AND HYDROGENATED VANADIUM (thesis). Ralph Hurley Van Fossen, Jr. (Ames Lab., Iowa State Univ. of Science and Tech.). Feb. 1965. Contract W-7405-eng-82. 60p. Dep. (mn); $3.00(cy), 2(mn) CFSTI.

Ductility surfaces were determined for pure and hydrogenated vanadium in the temperature range 77-297°K at strain rates from 0.001 $min.^{-1}$ to 5.4 $min.^{-1}$. By taking the difference between these two surfaces, an embrittlement surface was determined, showing the temperature-strain rate variation in degree of embrittlement conferred on vanadium by hydrogen. The embrittlement surface can be defined by two domains, which correspond exactly with those found for hydrogen embrittlement of steel. It was concluded that the same basic mechanism of hydrogen embrittlement is operative in both steel and vanadium. The results indicate that hydrogen in solid solution causes the embrittlement of vanadium. Because hydrogen does not affect the yield stress or flow stress of vanadium in the region of greatest embrittlement, however, it was concluded that hydrogen must lower the cohesive strength of the material. This was found to be consistent with an existing theory on hydrogen embrittlement. It is suggested that hydrogen ions in tetrahedral interstices in vanadium cause a decrease in metal-metal bond strengths across {100} planes. (P.C.H.)

22981 (LA-DC-7050) THE OXIDATION OF REFRACTORY METALS IN LIQUID SODIUM. James W. Williams (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 7p. (CONF-650411-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Joint NASA–AEC Liquid Metal Corrosion Meeting, Gatlinburg, Tenn.

The oxidation characteristics of various refractory metals were investigated for use as getters in sodium coolant purification systems. Materials studied as oxygen getters were Zr, Ta, Ta–10 W, Nb, 50 Ti–50 Zr, and U. Correlations are given for predicting hot trap kinetics in a closed loop. The Zr oxidation correlation was best at temperatures above 550°C. Although 50 Ti–50 Zr alloy appeared to be a more efficient hot trap than Zr, fabrication qualities were not as desirable. The oxidation rates of Ta and Ta–10 W can be kept below 0.1 mil/year in Zr hot trapped Na. (P.C.H.)

22982 (LA-DC-7051) MASS TRANSFER OF Ta IN MOLTEN Pu–Co–Ce FUELS—THE LINEAR DIFFUSION EXPERIMENT. J. C. Biery and C. R. Cushing (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [nd]. Contract W-7405-eng-36. 6p. (CONF-650411-2). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Joint NASA–AEC Liquid Metals Corrosion Meeting, Gatlinburg, Tenn.

Experiments on tantalum capsules in molten Pu–Co–Ce alloys at temperatures in the 600–800°C range are reported. Quantitative measurements were made on Ta mass transfer. Data from three different runs are summarized. The results from one run indicated that measurable quantities of Ta were dissolved by the 5 g Pu/cc Pu–Co–Ce fuel at 700°C. However, these quantities were very small and the rates of dissolution were low. (P.C.H.)

22983 (NAA-SR-Memo-10885) EFFECT OF EXTENDED EXPOSURE TO HEATED LiH ON TENSILE PROPERTIES OF 347 AND 321 STAINLESS STEELS. R. S. Neymark (Atomics International, Canoga Park, Calif.). Jan. 7, 1965. Contract [AT(11-1)-Gen-8]. 35p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Tensile specimens of Type 321 and of Type 347 stainless steel that which were exposed in LiH exhibited similar tensile properties to control specimens that were concurrently exposed in helium. The elongation observed in several test conditions with both Types 321 and 347 was as low as 18 to 20%, whether exposed in LiH or in helium. Type 316 had exhibited minimum elongations of about 22 to 23% under equivalent exposure and test conditions, and would be preferred over Types 321 or 347 if maximum ductility under all conditions was essential. Weight changes were determined for tabs of Type 347, 316, and 19-9 DL, which were included in the LiH with the tensile blanks. Type 316 had the smallest weight change and 19-9 DL the greatest, but none corroded appreciably (the maximum rate was less than 0.0004 inches per year). (P.C.H.)

22984 (NASA-CR-54167) POTASSIUM CORROSION TEST LOOP DEVELOPMENT. Quarterly Progress Report No. 4, April 15, 1964–July 15, 1964. E. E. Hoffman, ed. (General Electric Co., (Cincinnati, Ohio. Space Power and Propulsion Section)). Oct. 29, 1964. Contract NAS 3-2547. 82p.

Metallographic examination of specimens taken from the Loop I Nb–1 Zr tubing revealed varying degrees of excessive grain growth in all sections of the loop which were bent during fabrication and operated in excess of 1900°F. The strain-induced grain growth increased the grain diameters up to a factor of 25 times the pre-test diameters. Post-test ductility measurements revealed brittle transgranular fracture in specimens that had been exposed to a lower temperature than other specimens. Chemical analysis revealed a higher hydrogen content, but the source of this hydrogen is unknown. A purification process for reactor grade sodium metal for use in Loop II is described. The effects of three different surface treatments on the

emittance of Nb–1 Zr sheet were measured. It was found that grit-blasting with 50-μ alumina powder is effective in increasing the emittance of the pickled and dimpled sheet. Chemical analysis indicates no significant diffusion of oxygen into the alloy as the result of the residual alumina particles imbedded in the surface during grit-blasting. (W.L.G.)

22985 (NP-14951) THE THERMAL-MECHANICAL BEHAVIOR OF STRONTIUM ZIRCONATE. Bimonthly Progress Report No. 2, December 1, 1964–February 1, 1965. J. E. Funk, J. Nemeth, and J. R. Tinklepaugh (State Univ. of New York Coll. of Ceramics, Alfred Univ.). Contract NOw-65-0131-d. 14p.

Progress made in the construction of a new stress-strain apparatus for high temperature research is reported. The furnace was calibrated showing a temperature gradient of about 7°C along a 2 in. bar. X-ray investigations of solid solutions to enhance yield and/or strength have continued. High temperature crystal symmetry studies of $SrZrO_3$ indicate no transformation up to 1250°C. Preliminary results on the possibility of increasing the mechanical strength of $SrZrO_3$ are given. Future plans for studies on $SrHfO_3$ are discussed. (P.C.H.)

22986 (NRL-6231) INSTABILITY OF REFRACTORY METAL THERMOCOUPLES. B. E. Walker, Jr., C. T. Ewing, and R. R. Miller (Naval Research Lab., Washington, D. C.). Dec. 3, 1964. 16p. CFSTI.

Thermoelectric instabilities of some refractory metal thermocouples were studied in the temperature range 1000 to 2000°C under vacuum and neutron atmospheres. The sources of instability were found to be complex, involving contamination from ceramic protection tubes and furnace environments, preferential volatilization, and various thermal anomalies such as recrystallization and phase changes in the refractory thermoelements. Refractory thermocouples and thermoelements were studied under a variety of conditions, and emf changes associated with each were noted. Recommendations were made for the selection and application of these thermocouples to attain maximum thermoelectric stability. (auth)

22987 (NUMEC-3428-6) GROWTH OF SINGLE CRYSTALS OF PLUTONIUM. Quarterly Progress Report, October 1—December 31, 1964. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Contract AT(30-1)-2389. 14p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Progress is reported in the development and installation of a 150-kilobar opposed-anvil press for pressure transformation studies. Preparation of plutonium samples for pressure transformation studies and single-crystal growth by strain-anneal technique is reported. (W.L.G.)

22988 (NYO-2811-23) DEFECTS IN CRYSTALS. Annual Report, March 15, 1964–February 15, 1965. A. S. Nowick (Thomas J. Watson Research Center, International Business Machines Corp., Yorktown Heights, N. Y.). Contract AT(30-1)-2811. 84p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Anelastic relaxation in solid solutions of Ag–Zn was used to follow vacancy annealing. A plastic deformation of 2% and a lowering of the prior annealing temperature increased the rate of vacancy annealing. Vacancy interactions appear to play a minor role in vacancy annealing and oxygen contamination effects were inconclusive. Indications are that phase changes spoil the effect of a high temperature heat treatment. The existence of a dilatational irreversibility and the use of different exchange gases complicated the results obtained from the high-precision interferometric dilatometer and x-ray equipment used in the equilibrium studies of point defects in sodium. Tentative conclusions are that interstitials rather than vacancies are the predominant defect. An extension of a theory based on the thermodynamics of defect relaxations previously developed, which used the various types of relaxation to distinguish between defects of different symmetries and thus determine the structure of the defect, was made to include the kinetics of relaxation. The internal friction apparatus and the silicon specimen preparation for the measurement of the change in internal friction with temperature due to the configuration of the point defects changing from the application of stress are described. (W.L.G.)

22989 (ORNL-3776(p.37-40)) MELTING POINTS OF MIXTURES OF OXIDIZED FUEL CLADDING WITH UO_2. G. W. Parker and J. G. Wilhelm (Oak Ridge National Lab., Tenn.).

Movement of overheated UO_2 fuel in a loss-of-coolant reactor accident could occur at lower temperatures than were generally assumed due to interaction of oxidized cladding materials with the UO_2 fuel. It is of interest, therefore, to determine melting points of such mixtures. A resistance heating device was used in a preliminary examination of this problem. Iridium ribbons were used for measurements made in air, while W foil was used for vacuum measurements. A significant atmosphere effect on the melting point of stainless steel oxide–UO_2 mixtures was observed in tests with much lower values being obtained in air than in vacuum. Melting points increased with increased weight of UO_2 in the mixture. Oxidized stainless steel–UO_2 mixtures melted at 1500 to 1650°C, slightly lower in vacuum than in air. A ZrO_2–Zr–UO_2 composition prepared by melting a Zircaloy-clad UO_2 fuel specimen in air melted at 2150°C in air as compared with 1435°C for an oxidized stainless steel–UO_2 mixture under the same condition. (auth)

22990 (ORNL-P-1152) SUMMARY OF THERMOCHEMICAL DEPOSITION STUDIES AT OAK RIDGE NATIONAL LABORATORY, AUGUST 1964–MARCH 1965. R. L. Heestand, J. I. Federer, F. H. Patterson, and C. F. Leitten, Jr. (Oak Ridge National Lab., Tenn.). Contract [W-7405-eng-26]. 21p. (CONF-650419-1). Dep.(mn); $1.00(cy), 1(mn).

From Meeting of Refractory Composites Working Group, Atlanta.

Progress in chemical vapor deposition studies is reviewed. Particular emphasis is given to the studies carried out on deposition of tungsten–rhenium alloys and deposition of theoretically dense uranium dioxide. A brief résumé of the status of other vapor deposition programs is given including joining of tungsten by vapor deposition and deposition of tungsten sheet for mechanical and physical properties evaluation. (auth)

22991 (ORNL-P-1165) COMPARISON OF POLE FIGURE DATA OBTAINED BY X-RAY DIFFRACTION AND MICROHARDNESS MEASUREMENTS ON ZIRCALOY-2. P. L. Rittenhouse and M. L. Picklesimer (Oak Ridge National Lab., Tenn.). [1964]. Contract [W-7405-eng-26]. 20p. (CONF-650210-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Application of X-Ray Diffraction in the Atomic Energy Field Meeting, Richland, Wash.

A rapid and semiquantitative method of determining preferred orientation on large numbers of Zircaloy-2 specimens was desired. Knoop microhardness measurements were investigated as a solution to this problem. The variation of Knoop microhardness measurements on selected planes as a function of indenter axis relative to crystallographic or fabrication directions was determined for four lots of polycrystalline Zircaloy-2, on which both conventional and inverse pole figures had been determined, and seven Zircaloy-2 single crystals. Data from the single crystals were used to construct a polar coordinate hardness contour map. With use of an empirical relationship between the single crystal hardnesses and those of the polycrystalline material conventional pole figures could be constructed that compare favorably with those determined by x-ray diffraction. A quantitative relationship with inverse pole figure data was also obtained. To determine preferred orientation qualitatively from hardness data requires a minimum of twelve measurements per plane on three, preferably orthogonal, planes. The exact procedure requires attention to grain size, specimen preparation, and indenter load. The time required for preparation, measurement, and analysis is of the order of 45 to 60 min. (auth)

22992 (PAN-554/II) STANDARD BACK REFLECTION LAUE PATTERNS FOR FACE CENTERED CUBIC CRYS-

TALS. Stanislaw Szarras (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Oct. 1964. 11p. Dep.

The positions of diffraction spots on the back reflection Laue photographs for the three important crystallographic directions [001], [111], and [110] of face centered cubic crystals were calculated. The standard x-ray patterns for these three directions are plotted. (auth)

22993 (RISÖ-96) TENSILE PROPERTIES AT ROOM TEMPERATURE AND AT 400°C OF COMMERCIAL SINTERED ALUMINIUM PRODUCTS. Niels Hansen (Atomenergikommissionen, Risø (Denmark). Forsøgsinstitut). Dec. 1964. 30p. Dep.(mn).

Fourteen commercial sintered aluminium products were examined by tensile testing and chemical analysis in order to obtain a set of average properties of these types of material. Reasonably good relations between the tensile properties at room temperature and at 400°C and the oxide content were established for sintered aluminium products manufactured from milled aluminium powder. (auth)

22994 (RT/MET(64)-3) INFLUENZA DELLA VELOCITA DI RAFFREDDAMENTO DALLA FASE γ SULLA STRUTTURA DI LEGHE DI URANIO A BASSO TENORE DI TITANIO. (Influence of the Rate of Cooling from the γ Phase on the Structures of Uranium-Rich Alloys Containing Titanium). C. Fizzotti and G. Franceschetti (Comitato Nazionale per l'Energia Nucleare, Rome (Italy). Aug. 1964. 26p. Dep.(mn).

The influence of the cooling rate from the γ phase on the structure of uranium alloys containing up to 1.5 wt % titanium was investigated. Low cooling rates yielded fine dispersion of U_2Ti in the α matrix, while at high cooling rates fine lamellae were obtained. Water quenching caused the complete retention of titanium in solid solution yielding martensitic structures. The grains of the α matrix were progressively refined by increasing the cooling rates. (auth)

22995 (SWRI-1243-14(a)) DEVELOPMENT OF NONDESTRUCTIVE TESTING INSTRUMENTATION FOR REACTOR PRESSURE VESSELS. Appendices to Sixth Quarterly Report, April 1–July 10, 1964. John R. Barton and Robert D. Wylie (Southwest Research Inst., San Antonio, Tex.). Feb. 2, 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1243. 88p. (EURAEC-1345). Dep. (mn); $3.00(cy), 2(mn) CFSTI.

Information is presented on fabrication of ASTM A212B and A302B steel test specimens, test equipment, and procedures. Results of destructive and irradiation tests are included. (J.R.D.)

22996 (TID-21777) EFFECTS OF NEUTRON DAMAGE ON THE MECHANICAL PROPERTIES OF PYROLYTIC AND SINGLE-CRYSTAL GRAPHITE. Quarterly Progress Report No. 2, July 1–September 30, 1964. J. T. Meers (Union Carbide Corp., Parma, Ohio. Research Lab.). Oct. 1964. Contract AT(40-1)-3237. 46p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Small single crystals of graphite were grown in an iron–carbon melt at temperatures near 2700°C. Work was continued on the production and evaluation of compression annealed pyrolytic graphite. The average orientation of crystallites and some of the structural characteristics of these materials were determined by x-ray, optical, and electron microscope techniques. Preliminary values of Young's modulus, $^1/_{s_{11}}$, and the basal plane shear strength for compression annealed pyrolytic graphite are reported. Consistent results were obtained for the shear modulus, c_{44}, by both sonic and ultrasonic methods. The experimental equipment (the single crystal tensile testing apparatus, the simple shear wedges, and the resonant bar apparatus) is described. (auth)

22997 (TRG-Report-842) SUMMARIZED COMPATIBILITY REVIEW OF REACTOR MATERIALS FOR CO_2-COOLED GRAPHITE-MODERATED REACTORS. B. J. Seddon (Reactor Group, United Kingdom Atomic Energy Authority, Risley (England)). Sept. 23, 1964. 15p. Dep.; $0.50(BIS); 2s. 6d. (HMSO).

Discussion on the compatibility of a range of materials used in CO_2-cooled graphite-moderated reactors is included. Information is presented in the form of six tables based on compatibilities of materials with carbon dioxide, beryllium, Magnox, magnesium, uranium and compatibilities of pairs of other relevant materials. (P.C.H.)

22998 (UCRL-11251) ELECTROMAGNETIC PROPERTY MEASUREMENTS. Ira Pratt (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 1964. Contract W-7405-eng-48. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The response of a metallic specimen to an a-c magnetic field was examined in terms of resistivity and complex permeability. An equation describing the response as a function of frequency was developed and supported by experimental measurements. It was demonstrated that metals, i.e., copper and niobium, go through a susceptance transition to become diamagnetic, with an increase in field frequency. The same transition may be obtained with a decrease in resistivity, as associated with a decrease in temperature. For a special case, the equation is shown to reduce to a form of the Curie-Weiss relationship. The results indicate that when a susceptance measurement is used to indicate a superconductivity transition, valid comparisons with measurements taken at different frequencies (or by other methods) may not be made without incorporating a frequency correction term. (auth)

22999 (JPRS-28849(p.31-46)) DEVELOPMENT OF STUDIES OF THE RARE EARTH METALS AND ALLOYS IN THE INSTITUTE OF METALLURGY IMENI A. A. BAIKOV. V. F. Terekhova. Translated from p.30-41 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

Basic research studies are being conducted on: (1) physicochemical properties of the rare earth metals, (2) phase diagrams and properties of rare earth metal alloys, and (3) applications of the rare earth metals. (D.L.C.)

23000 (JPRS-28849(p.64-70)) MAGNETIC PROPERTIES OF ALLOYS OF GADOLINIUM WITH IRON, CERIUM, AND YTTRIUM. V. I. Chechernikov, I. Pop, and I. V. Burov. Translated from 55-9 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The magnetic susceptibility, magnetization, and Curie point were measured for Gd–Fe, Gd–Ce, and Gd–Y alloys over the entire concentration range from liquid-nitrogen temperature to the melting points. The results are discussed with respect to antiferromagnetism and magnetic structure. (D.L.C.)

23001 (JPRS-28849(p.81-5)) MAGNETIC PROPERTIES OF MONO- AND POLYCRYSTALLINE SCANDIUM. V. I. Chechernikov, I. Pop, and O. P. Naumkin. Translated from p.67-70 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The magnetic susceptibility was measured in a vacuum between 77 and 1100°K by the Faraday-Seksmit method, in which the force acting on the sample is measured by a thin elastic ring made of beryllium bronze. Since scandium is a weakly magnetic metal, impurities play an important role. Tests show that increasing the metal purity changes the magnetic moment from 1.65 to 1.42, while the paramagnetic Curie point changes from −1180 to −700°K. The Curie point was negative for all samples. It is possible, therefore, that scandium shows an antiferrite exchange interaction. Scandium single crystals were prepared by recrystallization annealing in a high vacuum; this method results in the lowest quantity of impurities. The temperature dependence of magnetic susceptibility was investigated in both directions, parallel or perpendicular to the c axis. The tests showed that the magnetic susceptibility was higher in a parallel field than in a perpendicular field. This shows that the magnetic moments are oriented along the c axis. The Curie point was −1300°K in the parallel magnetic field and −900°K in the perpendicular field. (D.L.C.)

23002 (JPRS-28849(p.86-97)) INVESTIGATION OF THE PROPERTIES OF METALLIC SCANDIUM. O. P. Naumkin, V. F. Terekhova, and E. M. Savitskii. Translated from p.71-8 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The metal used in the present tests was obtained by thermal reduction of scandium fluoride with calcium and either vacuum melting or vacuum distillation. Physico chemical properties of scandium were determined on samples of various purities. Thin films (400 A) of pure Sc were tested for corrosion. After 60 minutes at room temperature, an oxide film was formed on the scandium. After 10 minutes at 100°C, the quantity and intensity of Sc_2O_3 lines increased sharply. The nonoxidized metal remained in this condition up to 200°C. At 300°C for 2 hours, the scandium film was oxidized completely. Massive samples with a purity of 99.2% were also tested from 20 to 900°C. No weight gain is detected when massive samples of scandium heated up to 300°C for 24 hours. The highest rate of scandium oxidation is observed at 600-700°C. Electronic and X-ray analysis shows that the outer white layer on massive samples exposed to air consists of Sc_2O_3, while the inner darker layer is ScN. Single crystals of scandium obtained by recrystallization annealing were also tested. The thermoelectromotive force of a polycrystalline sample was found to be −5.32 μv/degree, compared to −2.65 for monocrystalline scandium parallel to the C axis and −8.04 perpendicular to the C axis. The anisotropy of the thermoelectromotive force of monocrystalline scandium was 3.03. Anisotropy of the microhardness of single crystals was also studied. (D.L.C.)

23003 (JPRS-28849(p.143-7)) METALLOGRAPHY OF SCANDIUM. O. P. Naumkin and V. F. Terekhova. Translated from p.112-15 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

A metallographic analysis was made of the admixtures and inclusions in metallic scandium of varying purity obtained by different methods. The microsections were made in the usual way and polished. Both etched and non-etched microsections were tested. In order to determine the distribution of oxides, the scandium samples were heated in air at 800°C for 2 hours. In fairly pure scandium, the admixtures are concentrated at the grain boundaries, which are clearly seen in the microsections. After prolonged polishing with an aqueous suspension, the microsection is coated with a dark oxide film and the grain boundaries become brighter. This resembles the microstructure of highly oxidized rare earth metals. When scandium is photographed on color film, the grains of various orientation have a bright pink or blue color. The microhardness of the scandium microsection was 120-140 kg/mm^2, while the microhardness of the inclusions was 450-500 kg/mm^2. (D.L.C.)

23004 (JPRS-28849(p.148-57)) PHASE DIAGRAMS WITH THE PARTICIPATION OF GADOLINIUM. I. V. Burov, V. F. Terekhova, and E. M. Savitskii. Translated from p.116-23 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

Four phase diagrams are presented for Mg−Gd, Ce−Gd, Fe−Gd, and Co−Gd, and the various phase relationships are discussed. A graph shows the types of phase diagrams and number of compounds formed by the reaction of Gd with elements of various subgroups of the periodic system. The use of the alloying principles in the selection of Gd alloys is illustrated with examples. The extension to other rare earths is considered, and a graph is given which shows the types of phase diagrams of La, Ce, and Gd alloyed among themselves and with Mg, Ti, Mn, and Fe. (D.L.C.)

23005 (JPRS-28849(p.158-65)) YTTRIUM AND PROSPECTS FOR ITS UTILIZATION. I. A. Markova, V. F. Terekhova, and E. M. Savitskii. Translated from p.124-8 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The basic physicochemical properties of Y are listed and discussed. Phase diagrams are given for the following systems: Mg−Y, Al−Y, Ti−Y, Sn−Y, Nb−Y, and Cr−Y. The differences in alloying behavior between Y and the rare earth metals are discussed. Trends in the utilization of Y in metallurgy, electronics, and nucleonics are described briefly. (D.L.C.)

23006 (JPRS-28849(p.184-7)) CRYSTAL STRUCTURE OF SILICIDES AND GERMANIDES OF THE RARE EARTH METALS. E. I. Gladyshevskii. Translated from p.141-3 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

Silicides of Tb, Dy, Ho, Er, Tm, Yb, Lu, and Y, and germanides of La, Ce, Nd, Sm, Eu, Tb, Dy, Ho, Er, Tm, Yb, Lu, and Y, were prepared by melting. Their crystal structures were determined and are tabulated. (D.L.C.)

23007 (JPRS-28849(p.188-91)) COMPOUNDS OF THE RARE EARTH METALS WITH ALUMINUM AND THEIR CRYSTAL STRUCTURES. P. I. Kripyakevich and I. I. Zalutskii. Translated from p.144-5 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The status of the studies of the systems of the rare earth metals with Al is surveyed briefly. Results are reported of studies of compounds in the systems Ce−Al, Pr−Al, Eu−Al, and Er−Al. From the data and the literature, it is concluded that, while the compound RAl_2 exists in all the systems, the composition of the compound richest in Al depends on the atomic radius of the rare earth metal. (D.L.C.)

23008 (JPRS-28849(p.191-4)) COMPOUNDS OF THE RARE EARTH METALS WITH MAGNESIUM AND THEIR CRYSTAL STRUCTURES. P. I. Kripyakevich and V. I. Evdokimenko. Translated from p.146-8 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

An x-ray diffraction study was made on alloys of Mg with La, Ce, Nd, Eu, Gd, Tb, Dy, Er, Yb, and Y. The crystal structures of the observed compounds are tabulated. It is concluded that the compound richest in Mg in the rare earths of the cerium group is R_2Mg_{17} or RMg_{12}, while in these of the yttrium group it is R_5Mg_{24}. (D.L.C.)

23009 (JPRS-28849(p.195-6)) X-RAY DIFFRACTION STUDY OF ALLOYS OF RARE EARTH METALS AND YTTRIUM WITH BERYLLIUM. E. I. Gladyshevskii, P. I. Kripyakevich, and D. P. Frankevich. Translated from p.149-50 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

A study was made of Be-rich alloys with all the rare earth metals except Pm and Gd. The results confirmed the hypothesis that a compound of the $NaZn_{13}$ type is formed in each system. The lattice constants a for the RBe_{13} compounds are listed. (D.L.C.)

23010 (JPRS-28849(p.197-8)) CRYSTAL STRUCTURES OF COMPOUNDS IN THE CERIUM−MANGANESE−COPPER−ALUMINUM SYSTEM AND IN THE TERNARY SYSTEMS THAT COMPRISE IT. E. E. Cherkashin, O. S. Zarechnyuk, P. I. Kripyakevich, and I. F. Kolobnev. Translated from p.151-2 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The compounds which exist in the ternary systems Ce−Mn−Al, Ce−Cu−Al, and Mn−Cu−Al are discussed. In order to determine what phases exist in equilibrium with the alpha phase in the Ce−Mn−Cu−Al system, x-ray diffraction studies were made on alloys with constant Al content (85.7 at. %). The results show that in addition to the compounds $MnAl_6$, $CeAl_4$, $CuAl_2$, $CeMn_4Al_8$, and $CeCu_4Al_8$, two quaternary compounds exist. The formula $Ce(Mn,Cu,Al)_{11}$ is assigned to the copper-rich compound. (D.L.C.)

23011 (JPRS-28849(p.199-200)) BINARY COMPOUNDS OF SCANDIUM WITH TRANSITION METALS AND BERYLLIUM. E. I. Gladyshevskii, P. I. Kripyakevich, Yu. B. Kuz'ma, and V. S. Protasov. Translated from p.153-4 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

Several scandium alloys containing Mn, Fe, Co, Ni, Cu and Re were investigated. The alloys were melted in an arc furnace or Tamman furnace in Al_2O_3 crucibles (in pure helium). X-ray analysis revealed the existence of $ScMn_2$, $ScCo_2$ and $ScNi_2$. For $ScFe_2$, a $MgCu_2$ type structure was observed. Consequently, $ScFe_2$ exists in two modifications. In the Sc−Re system, Sc_3Re_2 and Sc_5Re_{24} were found, analogously to the Zr−Re and Hf−Re systems. In the Sc−Co, Sc−Ni, and Sc−Cu systems, ScR compounds

of the CsCl type were found. In the Sc–Co and Sc–Ni systems, there were compounds with a high scandium content of the Ti_2Ni type. In the Sc–Be system only one compound was previously known–$ScBe_{13}$ of the same type as $NaZn_{13}$, but current tests showed the existence of at least two compounds–$ScBe_5$ ($CaCu_5$ type) and $ScBe_{17}$ (hexagonal structure). Thus, in systems with Mn, Fe, Co, Ni, Re and Be, scandium forms the same compounds as Zr and Hf, due to the close values of the atomic radii of scandium, zirconium, and hafnium. (D.L.C.)

23012 (JPRS-28849(p.201-6)) PHASE DIAGRAM OF THE La_2O_3–MgO SYSTEM. S. G. Tresvyatskii and L. M. Lopato. Translated from p.155-8 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

Samples of MgO and La_2O_3 were calcined at 1000°C, and the mixture was then triturated in an agate mortar and put into a furnace at 1200-1300°C for 2 hours; this process was repeated three times. The system was investigated by annealing and hardening in a furnace with a graphite heater in purified argon, the samples being melted in molybdenum crucibles. In some cases, tungsten crucibles were used. Phase analysis was done by x-ray and microstructural methods. The microstructure was studied in microsections in reflected and transmitted light and in powders by the immersion method. The x-rays show either La_2O_3 lines or La_2O_3 and MgO lines, no other lines being visible. Studies of microsections indicated that at first the lanthanum oxide crystallizes; La_2O_3 dendrites first appear at 30 mol. %. When the MgO content is above 50 mol. %, round isotropic grains of MgO can be seen. It is concluded that the compounds described by H. V. Wartenberg and K. Eckhardt (1937) in the La_2O_3–MgO system do not exist at temperatures above or equal to the solidus temperature. The system is eutectic with coordinates of the eutectic point equal to 52 mol. % La_2O_3 and 48 mol. % MgO. The fusion temperature of the eutectic is 2000 ± 20°C. (D.L.C.)

23013 (JPRS-28849(p.207-12)) STUDY OF THE PHASE DIAGRAM OF THE La_2O_3–Cr_2O_3 SYSTEM. S. G. Tresvyatskii and V. N. Pavlikov. Translated from p.159-62 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

Results are reported of investigations of the La_2O_3–Cr_2O_3 system in argon and in air. Phase transformations, as well as the liquidus temperature in argon, were studied in a high-temperature furnace with graphite heater. Both the phase transformations and the solidus temperature were studied by the hardening method. A URS-55a x-ray unit was used to study the microstructure. The tests showed that the La_2O_3–Cr_2O_3 system at high temperatures in the open air is a binary system with two eutectics, the chemical composition being 22 mol. % Cr_2O_3 and 78 mol. % La_2O_3 or 24 mol. % La_2O_3 and 76 mol. % Cr_2O_3, depending on the melting temperature of the eutectics. Study of the phase transformations is hampered by the high volatility of chromium oxide at high temperatures. Solid solutions are formed in the diagram between 83 and 100 mol. % La_2O_3. There were some differences in the system in argon and in air. (D.L.C.)

23014 (JPRS-28849(p.213-16)) CHEMICAL COMPOUNDS OF THE SCANDIUM–BORON SYSTEM AND THEIR PROPERTIES. G. V. Samsonov, T. S. Verkhoglyadova, and S. A. Vdovenko. Translated from p.163-5 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

Attempts were made to produce scandium borides by reacting Sc_2O_3 with boron or boron carbide. ScB_2 was formed at temperatures above 1600°. ScB_4 was also obtained, while ScB and ScB_{12} were not. The differences between the properties of ScB_2 and ScB_4 are described. (D.L.C.)

23015 (JPRS-28849(p.217-26)) PRODUCTION, PROPERTIES, AND PROSPECTS OF UTILIZATION OF SELENIDES OF THE RARE EARTH METALS. V. A. Obolonchik and G. V. Lashkarev. Translated from p.166-71 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The production of selenides directly from CeO_2 was investigated using pure Se and H_2Se at high temperatures. The reaction with Se resulted in the formation of Ce_2O_2Se, while that with H_2Se produced Ce_2Se_3. The production of selenides by reaction with H_2Se at 1100° was further investigated for the oxides of the other lanthanides. The results show that the selenides of Nd, Sm, Eu, and Tb were produced, while the other lanthanides formed oxyselenides. The physical properties and effective magnetic moments of the rare-earth selenides are tabulated. (D.L.C.)

23016 (JPRS-28849(p.238-43)) PRODUCTION OF THE DOUBLE BORIDE OF LANTHANUM AND SODIUM AND STUDY OF SOME OF ITS PHYSICAL AND CHEMICAL PROPERTIES. G. V. Samsonov, V. A. Obolochnik, Yu. V. Paderno, R. V. Serbina, V. S. Fomenko, and V. V. Ogorodnikov. Translated from p.180-3 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The double boride (La,Na)B_6 was produced by electrolysis of fused media. Its crystal structure is of the CaB_6 type, and the lattice periods increase with the sodium content. Its physical and chemical properties were studied. The change in the structure of LaB_6 upon introduction of an alkali metal into its composition is discussed. (D.L.C.)

23017 (JPRS-28849(p.250-63)) IMPROVEMENT OF THE PROPERTIES OF ACID OPEN HEARTH STEEL BY THE USE OF RARE EARTH METALS. Yu. V. Kryakovskii, Yu. I. Rubenchik, V. N. Lebedev, L. I. Nedosekin, P. T. Chumakov, and V. I. Yavoiskii. Translated from p.189-97 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

A preliminary study was made on the influence of rare earth metals on the properties of the acid rotor steels 34KhNMA and 40 KhGS. The macrostructure, plasticity, and impact ductility of transverse and longitudinal samples were studied. (D.L.C.)

23018 (JPRS-28849(p.279-85)) INVESTIGATION OF THE INFLUENCE OF RARE EARTH METALS ON THE QUALITY OF STAINLESS STEELS AND STEEL R18. V. S. Vvedenskii, K. K. Prokhorenko, P. L. Zhdanov, G. V. Semenchenko, N. E. Vasil'ev, Z. V. Verkhovtsev, and N. F. Nakonechnyi. Translated from p.209-13 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The study was undertaken to determine whether cerium introduced as a modifier would increase plasticity during rolling of steels 10Kh16N25M6 (austenite-carbide) and 07Kh25N13 (austenite-ferrite) which resist deformation. Tests were conducted under industrial conditions; ferrocerium corresponding to a Ce concentration of up to 0.4% was added to the metal before discharge or into the ladle. Additions of 0.2% to either steel increased plasticity during hot deformation. Increasing the Ce to 0.4% decreased plasticity, owing to the formation of specific defects near the surface in the transcrystalline zone consisting of accumulations of small inclusions, possibly cerium oxides and sulfides. In the 10Kh16N25M6 steel, such addition led to a change in the distribution of carbides in the case metal, owing probably to a decrease in carbon solubility; an increase in cerium favored carbide segregation throughout the grains rather than at their boundaries, leading to a more even distribution of carbides in the outer ingot layers. Such addition had no significant influence on the amount of the alpha phase and its distribution in the 07Kh25N13 steel. Its introduction led to a new form of non-metallic dot-like inclusions, apparently cerium oxysulfides, accumulating unevenly in the steel. Increasing the cerium addition led to a sharp decrease (to almost complete disappearance) of manganese and iron sulfides and silicates. Cerium modification of the 10Kh15N25M6 steel at a 0.15–0.20% concentration resulted in increased exterior and interior plasticity and increased the yield of suitable blooms by 8%. Ferrocerium or a mixture of rare earth metals was added to the R18 steel after reduction; performance and red hardness were determined after oil quenching. Red hardness increased by 25°C, due to the increased resistance of the martensite to heating. Polished

specimens of the cast steel showed a more even distribution of the ledeburite eutectic; this increased the plasticity during rolling. The modifier did not increase the yield. (auth)

23019 (JPRS-28849(p.292-6)) DISTRIBUTION OF LEAD AND CERIUM IN IRON, NICKEL, AUSTENITE STEEL, AND THE NICKEL ALLOY E1765. M. V. Pikunov, A. S. Petukhova, L. A. Voskresenskaya, and I. P. Izotova. Translated from p.218-21 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The influence of cerium addition on the distribution of lead in iron, nickel, austenite steel, and alloy E1765 was investigated by determining the different x-ray absorption coefficients for the alloy components. The tests involved annealed specimens of Kh15N25 steel containing 0.6% each of Pb and Ce, nickel with 0.2% of each, and alloy E1765 with 0.05% of each. The results showed that cerium additions have no effect on the lead distribution in austenitic steel, but does cause a more even distribution in iron. No primary crystallization of lead and cerium compounds occurred in either iron or steel. Cerium addition induced changes in the solidification of the E1765 alloy with Pb; after annealing, the Ce and Pb-enriched inclusions did not dissolve, as is usually the case if only Ce or only Pb are added. It may be assumed that Ce additions cause a shift in the alloy composition to a region where crystallization is terminated by the solidication of a eutectic containing not Pb but some complex compound of Pb, Ce, and possibly Ni. Since luminous inclusions in the E1765 with 0.05% Pb and Ce were more numerous than those in nickel with 0.2% of each, a sharply increasing liquation of Cr, Mo, Ti, and Al in the presence of Ce and Pb may be assumed. (auth)

23020 (JPRS-28849(p.297-302)) INFLUENCE OF THE RARE EARTH METALS ON THE STRUCTURE AND PROPERTIES OF CONSTRUCTION STEELS. E. M. Savitskii, V. F. Popov, and N. V. Keys. Translated from p.222-5 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The selection of steels for which addition of rare earth metals (REM) would be most effective, the quantity of REM to be added, and their mode of introduction into the steel were studied in the following experimental, high-quality alloys prepared in pilot plants prior to introduction into manufacture: 18KhNVA, 30KhGSA, 12Kh2N4A. The first alloy had a tendency to form intercrystalline grooves causing "spiders" and laminations in the quenched metal, while the last 2 had low impact strength. The work was done under manufacturing conditions. Ferrocerium at a 0.1–0.28% concentration was added to the liquid steel in the ladle or during filling of the molds. Small cubes cut from various parts of the ingots served for the tests. The results showed a decrease in sulfur content by 20-30%. The macrostructure of the ingot improved, with a decrease in grain size. The mechanical properties of cast steel improved much more than those of quenched steel. This favorable influence of REM was most pronounced in 18KhNVA whose strength, plasticity, and impact toughness improved by 12, 15, and 4%, respectively. The addition had an unfavorable effect on macrostructural flow. REM apparently facilitate the purification of liquid steel but introduce the products of chemical reactions with the impurities as complex refractory oxysulfides which may serve as additional crystallization centers; however, due to their surface-active properties, they also impede the growth of dendrite crystals during primary crystallization. (auth)

23021 (JPRS-28849(p.303-9)) INFLUENCE OF RARE EARTH METALS ON THE STRUCTURE AND PHYSICAL PROPERTIES OF TECHNICAL IRON, NICKEL, AND COBALT. V. P. Taratynov, O. P. Elyutin, and I. N. Gerasimova. Translated from p.226-31 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

The required conditions for producing the maximum physical properties of alloys with a minimum expenditure of rare earths are outlined. The effects of the method of introduction of Nd into iron on the residual Nd content were studied, and it was determined that the introduction of Nd as a master alloy into the open induction furnace produces the most complete purification of iron. Additions of Ce, La, Nd, Pr, and Y within their solubility limits in the solid state also promotes purification of technical Fe, Ni, and Co, influence the grain size, and improve the properties. (D.L.C.)

23022 (JPRS-28849(p.310-18)) INFLUENCE OF RARE EARTH METALS ON THE PLASTICITY AND STRUCTURE OF STAINLESS STEELS. N. F. Nakonechnyi and K. K. Prokhorenko. Translated from p.232-7 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

To prevent losses caused by the low plasticity of stainless steel ingots, the plasticity of the transcrystalline and equiaxial crystal structures was compared in specimens of 07Kh25N13 (austenite-ferrite) and 10Kh16N25M6 (carbide) steel ingots by means of bending tests at 800°C. While a lower plasticity was more frequently seen in the transcrystalline than in the small equiaxial crystal structure, this was not an absolute rule, since plasticity also depends on the prevalence of the ferrite or carbide phase in the biphasic system. The influence of ferrocerium additions corresponding to 0.1–0.4% cerium to the molten steel was tested by heating at 1000-1250°C for short periods of time. A 0.2–0.3% addition increased plasticity; this effect was more pronounced in single-phase austenitic steel. The structure was also studied after quenching at various temperatures. No significant influence of cerium upon the macrostructure of the steel ingot (size of transcrystalline and equiaxial crystal zones) was observed; the equiaxial crystals, however, were somewhat smaller. Increasing the cerium addition caused a return to the initial structure. There was no effect on the size of the ferrite phase in austenitic steel at 1000-1300°C, nor on the content of carbide and carbonitride phases in 10Kh16N-25M6 steel. However, the composition and form of the phase separation might change under the influence of cerium. The increased plasticity of these steels due to such small additions may be due to a change in the distribution of microchemical heterogeneities in the steel and a decrease of non-metallic inclusions. Higher additions will increase the contamination of the ingot surface layers. (auth)

23023 (JPRS-28849(p.333-41)) MICRODIFFUSION OF CERIUM AND ITS INFLUENCE ON THE DIFFUSION PARAMETERS AND STRUCTURE OF IRON–CARBON ALLOYS. G. N. Bakakin, A. P. Lyubchenko, M. V. Mozharov, and D. G. Sherman. Translated from p.248-54 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

An investigation was made of the distribution of Ce in the microvolumes of cast irons, the diffusion of Ce during crystallization, and the effects of Ce on the diffusion parameters and structure of the phases of cast iron. ^{144}Ce and ^{59}Fe were used as tracers in the diffusion studies. X-ray diffraction studies show that in all the cast irons, graphite is almost entirely represented by the α phase. The diffusion results show that the diffusion parameters of C–Fe alloys are unchanged when up to 0.5% Ce is introduced. (D.L.C.)

23024 (JPRS-28849(p.342-50)) INVESTIGATION OF THE INFLUENCE OF RARE-EARTH METALS ON THE THERMAL STABILITY OF CARBIDES IN CAST IRON. N. A. Sidorov and E. M. Shkol'nikov. Translated from p.255-60 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

A study was made of the effects of Ce, La, Nd, and Pr on the stabilization of the carbides and the formation of graphite in eutectic cast iron. Stabilization was achieved by 0.1–0.2% Ce and 0.6–0.8% La, Nd, and Pr. If the modifier content is below this, the ability of the cast iron for bleaching is reduced, and in the case of La, graphitization during solidification is increased sharply. (D.L.C.)

23025 (JPRS-28849(p.357-61)) PRODUCTION OF HIGH-STRENGTH CAST IRON MODIFIED WITH RARE-

EARTH METALS. V. P. Khramov, S. B. Pirkes, M. G. Shestakova, and A. A. Strelkova. Translated from p.265-8 of "Voprosy Teorii i Primeneniya Redkozemel'nykh Metallov."

An investigation was made of the effects of modifying additives on the formation of globular graphite in cast iron. The results show that, for Ce, globular graphite is well formed at low sulfur contents. Modification by La and rare earth oxides is also considered. The mechanical properties of cast iron after annealing to a pearlite structure are listed. Results of wear tests of modified cast-iron bushings, valve seats, and piston rings are given. Studies of methods for the determination of Ce in iron are described briefly. (D.L.C.)

23026 THE CRYSTAL STRUCTURE OF $ReSe_2$. N. W. Alcock and A. Kjekshus (Universitetet, Oslo). Acta Chem. Scand., 19: 79-94(1965).

The existence of one intermediate phase, the $ReSe_2$ phase, was established in the rhenium-selenium system. The structure is triclinic with the lattice constants: a = 6.7272, b = 6.6065, and c = 6.7196Å; and α = 118.93, β = 91.82, and γ = 104.93°. The pycnometric density is 9.237 g cm^{-3} at 25°C. The space group is P1 and the unit cell contains Re_I, Re_{II}, Se_I, Se_{II}, Se_{III}, and Se_{IV} in (i) ± (x,y,z): Re_I, with x_1 = 0.4937, y_1 = 0.3038, z_1 = 0.3020, B_1 = 1.0; Re_{II}, with x_2 = 0.4943, y_2 = 0.7474, z_2 = 0.3027, B_2 = 1.0; Se_I, with x_3 = 0.2228, y_3 = 0.4875, z_3 = 0.3600, B_3 = 1.6; Se_{II}, with x_4 = 0.2220, y_4 = 0.9830, z_4 = 0.3620, B_4 = 1.6; Se_{III}, with x_5 = 0.7089, y_5 = 0.4893, z_5 = 0.1221, B_5 = 1.2; and Se_{IV}, with x_6 = 0.7089, y_6 = 0.9893, z_6 = 0.1221, B_6 = 1.2. The $ReSe_2$ phase has diamagnetic susceptibility. Its structure is related to the $Cd(OH)_2$ type structure and it also shows similarities to rhenium cluster compounds. (auth)

23027 ON THE ARSENIDES AND ANTIMONIDES OF TANTALUM. Sigrid Furuseth, Kari Selte, and Arne Kjekshus (Universitetet, Oslo). Acta Chem. Scand., 19: 95-106(1965).

The phase relationships in the systems tantalum-arsenic and tantalum-antimony were studied by the x-ray method. Density determinations and magnetic susceptibility measurements were carried out. Five intermediate phases were identified: TaAs, with NbAs-type structure, a = 3.4348 and c = 11.641Å, density = 12.25 g cm^{-3}; $TaAs_2$, with $NbAs_2$-type structure, a = 9.3385, b = 3.3851, and c = 7.7568Å, β = 119.70°, density = 10.26 g cm^{-3}; Ta_3Sb, with βW-type structure, a = 5.2646Å; and Ta_5Sb_4, with Ti_5Te_4-type structure, a = 10.248 and c = 3.5460 Å, density = 12.22 g cm^{-3}; and $TaSb_2$, with $NbAs_2$-type structure, a = 10.2218, b = 3.6447, and c = 8.2915Å, β = 120.39°, density = 10.53 g cm^{-3}. The TaAs, $TaAs_2$, and $TaSb_2$ phases have diamagnetic susceptibilities, whereas the Ta_5Sb_4 phase showed weak temperature-independent paramagnetism. (auth)

23028 THE CRYSTAL STRUCTURES OF $NbAs_2$ AND $NbSb_2$. Sigrid Furuseth and Arne Kjekshus (Universitetet, Oslo). Acta Cryst., 18: 320-4(Mar. 10, 1965).

The compounds $NbAs_2$ and $NbSb_2$ are isostructural. The monoclinic unit cells have the following dimensions: for $NbAs_2$, a = 9.357, b = 3.3823, c = 7.792 Å, and β = 119.46°, for $NbSb_2$, a = 10.239, b = 3.6319, c = 8.333 Å and β = 120.07°. The space group is $C2(C_2^3)$ and the unit cell contains 4 Nb and 2 × 4 As (Sb) in general positions 4(c). The parameters were found to be for Nb, x_1 = 0.3444, y_1 = ½, and z_1 = 0.3044; for As_I, x_2 = 0.0948, y_2 = 0.488, z_2 = 0.3928; for As_{II}, x_3 = 0.1399, y_3 = 0.067, and z_3 = 0.0257 for $NbAs_2$ and Nb, x_1 = 0.343, y_1 = ½, z_1 = 0.304; for Sb_I, x_2 = 0.096, y_2 = 0.5, and z_2 = 0.393; for Sb_{II}, x_3 = 0.142, y_3 = 0.0, and z_3 = 0.027 for $NbSb_2$. The relationships to the $CuAl_2$, $PbCl_2$, MoP_2, and marcasite types of structure are discussed in terms of the general (8-N) rule. (auth)

23029 TRANSLATION-PERMUTATION OPERATOR ALGEBRA FOR THE DESCRIPTION OF CRYSTAL STRUCTURES. II. INTERSTICE LATTICE STACKING FAULTS. William G. Gehman and Stanley B. Austerman (Atomics International, Canoga Park, Calif.). Acta Cryst., 18: 375-80(Mar. 10, 1965).

Interstice lattice stacking faults (ILSF) are predicted for all crystal structures that are composed of both anion lattices that are ideally closest packed and cation interstice lattices that are only partially occupied. For brevity, theoretical examples are given only for the ZnS, CdX_2, and spinel structures. Translation-permutation operator representations are presented for basal and prismatic ILSF, which, respectively, lie perpendicular and parallel to the stacking axis, and for pyramidal ILSF, which are tilted with respect to the c axis. Local charge unbalance occurs in both the basal and prismatic ILSF, and the basal ILSF also exhibits a local non-stoichiometry. Experimental examples of isolated ILSF in BeO bicrystals are presented. (auth)

23030 THE CRYSTAL STRUCTURE OF β-BERYLLIA. Deane K. Smith (Univ. of California, Livermore), Carl F. Cline, and Stanley B. Austerman. Acta Cryst., 18: 393-7 (Mar. 10, 1965).

The crystal structure of β-beryllia was determined from x-ray powder data collected at 2100°C. The structure is tetragonal with a = 4.75 and c = 2.74 Å, and contains four molecules of BeO in the unit cell. The density is 2.69 g cm^{-3}. The structure is related to rutile, TiO_2, in that the oxygen arrangement is identical. Beryllium atoms are in tetrahedral sites. The space group is $P4_2/mnm$, and the oxygen and beryllium atoms are in sites 4(f) and 4(g) respectively with x_0 = 0.310 and x_{Be} = 0.336. (auth)

23031 THE CONSTITUTION OF THE SODIUM-RICH REGION OF THE SODIUM-URANIUM-OXYGEN SYSTEM. R. T. Pepper, J. R. Stubbles, and C. R. Tottle. Appl. Mater. Res., 3: 203-7(Oct. 1964).

The phases present at equilibrium in the sodium-rich region of the sodium-uranium-oxygen system in the temperature range from 600 to 1000°C were determined. Results showed three phase field of Na, UO_2, and a phase X in the Na-rich region of the system for oxygen-uranium ratios between 2 and 4 at 850°C. Phase X had a fcc structure and chemical analysis indicated a formula of Na_3UO_4. X-ray analysis showed this particular three phase region to extend over the temperature range from 600 to 1000°C. (Rev. Metal Lit., 22: (Feb. 1965))

23032 HIGH TRANSITION TEMPERATURE SUPERCONDUCTING A 15 ALLOYS (β TUNGSTEN). P. Pietrokowsky (Fulbright Research Scholar, Oslo). Appl. Phys. Letters, 6: 132-4(Apr. 1, 1965).

The crystal structure of nine Au-Pt-Ti alloys was studied at room temperature. It was concluded that the alloys are essentially a mixture of two phases, both of which are closely related to the A-15-type crystal structure. (D.C.W.)

23033 MODIFICATIONS PRODUCED BY CHILLING AND THEIR CRYSTAL GROWTH IN THE SYSTEMS CONTAINING ZIRCONIUM DIOXIDE. A. Krauth and H. Meyer (Max-Planck-Institut für Silikatforschung, Wurzburg, Ger.). Ber. Deut. Keram. Ges., 42: 61-72(Mar. 1965). (In German)

Particles, 30-50 μm, of pure ZrO_2 and with various additions were melted in a plasma jet, severely chilled by spraying on a cold metal plate, and then investigated by x-ray methods at room temperature. Whereas the pure ZrO_2 gave only the monoclinic crystal form (no modification was produced by chilling), the effects of the additions of SiO_2, Al_2O_3, and ZrN were to produce a tetragonal high-temperature form of ZrO_2. The additions promoted the formation of very fine crystallites, and their total surface resulted in an energy sufficient for the formation of the tetragonal higher-energy modification. During annealing of chilled specimens the crystallites grew to the maximum crystal size of the tetragonal modification, this maximum being dependent on the boundary-surface energy of the given system. If the maximum size was exceeded, the lower-energy monoclinic modification resulted. In the system ZrO_2-Al_2O_3 a region was found in which the chilled specimens vitrified. The density, refraction, and crystallization behavior of such glasses were studied as functions of composition. This glass formation was attributed to the presence of Al ions in four-fold coordination. (auth)

23034 THE PROBLEM OF CLADDING MATERIALS IN THE HEAVY WATER–GAS DEVELOPMENT LINE. Marc Salesse. Bull. Inform. Sci. Tech. (Paris), No. 87, 27-9(Oct. 1964). (In French)

Problems in the development of a cladding material with the required high temperature resistance and low neutron absorption are considered. In France, the majority of efforts are concentrated on beryllium, but other materials are also being studied. The status of these studies and the prospects they offer are outlined. (auth)

23035 THE INTERNAL FRICTION PEAKS IN AN ALLOY OF NIOBIUM WITH 4.8% TITANIUM. Georges Vidal and Herve Bibring (Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux, France). Compt. Rend., 260: 857-60(Jan. 18, 1965). (In French)

An alloy of niobium with 4.8% titanium has, at a frequency of 0.6 Hz, internal friction maxima due to oxygen at 100°C and nitrogen at 340°C, whereas these points are located at 150 and 285°C, respectively, in non-alloyed niobium. (tr-auth)

23036 EFFECT OF THE PURITY OF ALUMINUM OF HIGH TITER ON THE KINETICS OF ITS RECRYSTALLIZATION. Robert Fromageau and Philippe Albert (CNRS, Vitry-sur-Seine, France). Compt. Rend., 260: 895-8 (Jan. 18, 1965). (In French)

The effect of the degree of purity of the recrystallization kinetics of aluminum after rolling at the temperature of liquid nitrogen was studied. The rates of germination and crystal growth and the corresponding activation energies were determined for monocrystals of the same orientation and for polycrystalline samples. (tr-auth)

23037 THORIUM–TRANSITION METALS TERNARY GERMANIDES. M. Sikirica and Z. Ban (Institut "Rudjer Boskovic," Zagreb). Croat. Chem. Acta, 36: 151-8(1964).

Compounds of the general composition ThM_2Ge_2 (M = Cr, Mn, Fe, Co, Ni, and Cu) were synthetized from elements in an electron-beam furnace. They were isostructural with the series ThM_2Si_2 having a tetragonal unit cell with two formula units. The a and c dimensions of the unit cells are for Cr: 4.11, 10.83; for Mn: 4.084, 10.930; for Fe: 4.098, 10.222; for Co: 4.109, 9.934; for Ni: 4.161, 9.677; and for Cu: 4.152, 10.140 Å, the standard deviation was ±0.002 and ±0.004 Å for a and c, respectively. Thorium and transition metal atoms are in special positions 2(a) and 4(d), respectively. All the interatomic distances, including Ge, are given. (auth)

23038 THE YOUNG'S MODULUS OF α-PLUTONIUM AT LOW TEMPERATURE. P. F. T. Linford (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Cryogenics, 4: 395(Dec. 1964).

A series of experiments determining Young's modulus of α-plutonium at 20 to 300°K was performed, and a typical result is shown. (L.B.S.)

23039 NIOBIUM ALLOY DEVELOPED. Engineer, 219: 355(Feb. 19, 1965).

Properties of the niobium alloy SU16 are described. The composition of the alloy is 11% W, 3% Mo, 2% Hf, 0.08% C, and the remainder niobium. It can be crystallized after cold working without loss of ductility and welds have excellent properties. It retains most of its strength up to 1316°C. (M.C.G.)

23040 INVESTIGATION OF THE EPITAXY OF ALPHA-IRON, MOLYBDENUM AND ALPHA-TUNGSTEN WITH THEIR CUBIC NITRIDES. Helmut Gunther Schneider. Freiberger Forschungsh. B, 71: 84p.(1964). (In German)

Morphological investigations were made, using x-ray diffraction techniques, of the epitaxy of alpha iron with such cubic nitrides as Fe_4N and $Fe_{16}N_2$, of Mo with Mo_2N, and of alpha tungsten with W_2N, $W_{0.75}(N,O)_{1.00}$, and $W_{0.62}N_{0.62}O_{0.38}$. An analysis was made of the orientation relationships. Application in the surface hardening of metals are discussed. (Rev. Metal Lit., 22: (Feb. 1965))

23041 CALCULATION OF THE TEMPERATURE AND CONCENTRATION DEPENDENCES OF SOME THERMODYNAMIC FUNCTIONS OF NbC_x PHASES. R. G. Avarbe and Yu. N. Vil'k (State Inst. of Applied Chemistry, USSR). High Temp. (USSR) (English Transl.), 2: 370-4(May-June 1964). Translated from Teplofiz. Vysokikh Temp., 2: 406-10(May-June 1964).

Using the Dunwald-Wagner and Avarbé-Nikol'skii equations, the temperature and concentration dependences of some thermodynamic functions of a binary alloy which evaporates from a free surface in vacuum without changing its composition, were derived. Using the data published by Fries concerning the congruently evaporating different phases of niobium monocarbide at 2940°K and 3130°K, the numerical values of the constants in the equation giving the temperature and concentration dependences of the thermodynamic functions of these phases were determined. The solubility of graphite in niobium carbide was calculated as a function of the variation of the composition and temperature of congruently evaporating phases. Thermodynamic functions such as activity, isobaric-isothermal potential, and the enthalpy and entropy of formation of the homogeneous phase NbC_x were calculated as a function of the concentration at 2940°K. (auth)

23042 STUDY OF THE DIFFUSION OF SOLID-STATE RADIOTRACERS BY THE GRUZIN METHOD. G. Seibel (IRSID, St-Germain-en-Laye, France). Intern. J. Appl. Radiation Isotopes, 15: 679-93(Nov. 1964). (In French)

The sectioning method derived by Gruzin was generalized: it can be applied for plotting point by point solid-state diffusion curves of radiotracers in several types of diffusion specimen for any diffusion law. Diffusion of sulfur-35 and phosphorus-32 in iron was taken as an example to show that this method is adapted to different radiations emitted by radioelements, particularly, low-energy β radiation, and electromagnetic radiation. (auth)

23043 MECHANICAL PROPERTIES OF QUATERNARY ALLOYS OF THE Nb–W–Mo–Zr SYSTEM AT 1000-1600°C. E. M. Savitskii and A. M. Zakharov. Izv. Vysshikh Uchebn. Zavedenii, Chernaya Met., No. 1, 104-9(1965).

A series of Nb alloys containing W, Mo, and Zr were previously investigated. On the basis of preliminary experiments, several alloys were selected for further examination. The quaternary alloys of the Nb–W–Mo–Zr system had the highest mechanical properties due to a more complex composition of solid solution and the presence of $(W, Mo)_2Zr$ strengthening phase in their structure. An analysis of the test data showed a correlation between the tensile strength, σ_B, and hardness of alloys, expecially at 1300 to 1500°C. (CFSTI)

23044 DISLOCATION-INTERSTITIAL INTERACTIONS IN SINGLE-CRYSTAL TANTALUM. S. H. Carpenter and G. S. Baker (Aerojet-General Corp., Sacramento, Calif.). J. Appl. Phys., 36: 1733-8(May 1965).

Dislocation–interstitial interactions were investigated in zone-melted single-crystal tantalum by means of internal friction measurements. A Marx piezoelectric composite oscillator resonating at 50 kc was used to measure the logarithmic decrement as a function of time, temperature, and strain amplitude. Damping measurements indicate that two separate pinning processes occur in the 0–100°C temperature range. In the 0–25°C range the amplitude-independent damping measured immediately following deformation (~1%) was found to decrease with time. No change in the amplitude dependence was detected. This was called stage-one pinning. The relaxation time for stage-one pinning was found to be too short to allow for the long-range diffusion of interstitials required for Cottrell-type pinning. The pinning mechanism is believed to be the reorientation of solute interstitial oxygen atoms in the dislocation strain field as proposed by Schoeck. The activation energy for the stage-one process was found to be 23,500 ± 3,000 cal/mole. This value is consistent with the diffusional energy of oxygen in tantalum. An increase in test temperature to the 75–100°C range was found to cause a further reduction of the amplitude-independent damping with time. A decrease in the amplitude dependence was also observed. This reduction in the damping was called stage-two pinning. Stage-two pinning is explained satisfactorily by the Cottrell-type pin-

ning of the dislocation lines by solute interstitial oxygen atoms. (auth)

23045 HIGH-TEMPERATURE HEAT CONTENTS OF TiC AND ZrC. Leonard S. Levinson (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 42: 2891-2(Apr. 15, 1965). (LA-DC-6635)

Using a drop calorimeter, the heat content of TiC was measured between 1274 and 2799°K, and that of ZrC between 1275 and 2788°K. (auth)

23046 DENSITIES, VOLUMES, EXPANSION COEFFICIENTS AND ATOMIC CELL DIMENSIONS OF METALLIC MERCURY FOR ITS ENTIRE SOLID AND LIQUID TEMPERATURE RANGE, i.e., FROM ZERO ABSOLUTE TO ITS CRITICAL POINT (1733°K). Aristid V. Grosse (Temple Univ., Philadelphia). J. Inorg. Nucl. Chem., 27: 773-86 (Apr. 1965).

An attempt was made to present the complete volumetric behavior of mercury, as a function of temperature, over the entire solid and liquid range, i.e., from 0°K to the critical point, from all available information. Data are presented on solid mercury from 0°K to the melting point. The results, obtained by a wide variety of methods, are consistent and unify microscopic and macroscopic measurements. (auth)

23047 USE OF THE JOMINY END-QUENCH TEST TO EXPLORE THE TRANSFORMATION CHARACTERISTICS OF SOME URANIUM ALLOYS. D. J. Marsh, G. F. Slattery, and J. H. Gittus (United Kingdom Atomic Energy Authority, Preston, Lancs, Eng.). J. Inst. Metals, 93: 260-7(Apr. 1965).

Binary, ternary, and quaternary alloys of uranium with molybdenum, chromium, niobium, iron, and aluminum were end-quenched from 720 and 800°C by means of a Jominy rig. The resultant α grain size depended on the arithmetic sum of the grain-refining effects, which each of the alloying elements, separately, produced. This meant that, for grain refinement, there was no merit in the use of more than one alloying element. Some of the alloys, particularly the simple uranium–chromium binaries, transformed by a shear process, and this may be an undesirable characteristic. Of the remainder, uranium–2.5 at. % niobium and uranium–1 at. % niobium–0.5 at. % chromium were promising; they gave a fine grain size when cooled at 100°C/min (air-cooling), the transformation did not appear to involve shear processes, and the product contained a finely dispersed second phase, which may confer good resistance to isotropic radioinduced swelling. (auth)

23048 THE OCCURRENCE OF METASTABLE TETRAGONAL ZIRCONIA AS A CRYSTALLITE SIZE EFFECT. Ronald C. Garvie (Bureau of Mines, College Park, Md.). J. Phys. Chem., 69: 1238-43(Apr. 1965).

Metastable tetragonal ZrO_2 was prepared in two ways: precipitation from alkaline aqueous solution and low-temperature calcination of zirconyl nitrate. Both methods are standard techniques for preparing active powders with large surface area. This suggested that the excess surface energy (relative to a large single crystal) present stabilized the tetragonal form. The maximum specific surfaces were 194 and 15.6 m^2/g, for the products of the first and second methods, respectively, corresponding to crystalline sizes of 54 and 155 Å. The excess energy of the active powders ranged as high as 6.7 kcal/mole. There appeared to be a critical crystallite size, about 300 Å, above which the metastable tetragonal phase could not exist at room temperature. Thermodynamic calculations showed that, if the surface free energy of ZrO_2 increased from 770 to 1130 ergs/cm^2 upon passing from the tetragonal to the monoclinic structure at 300°K, then the occurrence of the metastable tetragonal form could be accounted for as a crystallite size effect. (auth)

23049 RELATION BETWEEN SPECIFIC HEAT AND TOTAL EMITTANCE IN TANTALUM, NIOBIUM, TUNGSTEN, AND MOLYBDENUM. H. V. L. Narasimhamurty, A. S. Iyer, and M. Hoch (Univ. of Cincinnati). J. Phys. Chem., 69: 1420-3(Apr. 1965).

The ratio of specific heat to total emittance $C_{p/\epsilon}$ was determined by measuring the cooling rate of metal rods and disks of various sizes and shapes under vacuum. The method does not require any instrumentation of the sample and permits easy preparation of the surface. The value of $C_{p/\epsilon}$ was found to be constant for tantalum, niobium, tungsten, and molybdenum in the temperature range from 1250 to 2350°K. (auth)

23050 ELECTRICAL PROPERTY OF URANIUM DIOXIDE. Shoji Iida (Mitsubishi Atomic Power Industries, Inc., Ohmiya, Saitama Prefecture, Japan). J. Phys. Soc. Japan, 20: 291-2(Feb. 1965).

Electric conductivities of uranium oxide samples in the range $UO_{1.99}$ to $UO_{2.00}$ were measured at 77 to 1100°K, after sintering at 1800, 2000, and 2200°C, and arc fusing. Measured conductivities and the derived activation energies are presented. (M.J.T.)

23051 NEW BERYLLIUM–ALUMINUM ALLOYS. Light Metal Age., 22: No. 9-10, 12; 32(Oct. 1964).

Technical information is presented on a Be–Al alloy, named Lockalloy, which combines temperature values of Be with workability of Al. Mechanical and physical properties, bearing properties at room temperature, joining techniques, and machinability are described. Lockalloy is expected to find application in missiles, satellite launch vehicles, and supersonic aircraft. (Rev. Metal Lit., 22: (Feb. 1965))

23052 A THEORY OF THE ELECTRICAL PROPERTIES OF LIQUID METALS. IV. QUANTITATIVE CALCULATIONS OF RESISTIVITY AND THERMOELECTRIC POWER. Lorna J. Sundstroem (Cambridge Univ., Eng.). Phil. Mag. (8), 11: 657-65(Apr. 1965).

Following the lines of the pseudopotential approach to the electronic transport properties of liquid metals as presented by Ziman and Bradley, systematic quantitative calculations were made for the electrical resistivity and thermoelectric power of the liquid metals: Li, Na, K, Rb, Cs, Zn, Hg, Al, Tl, Pb and Bi. The pseudopotential used is that of Heine and Abarenkov. The results are in fair agreement with experiment. Some deviations from the experimental figures may perhaps be rectified by refinements to the pseudopotential employed; and in other cases the correlation functions, as deduced from x-ray and neutron diffraction experiments, may be in error. (auth)

23053 THE YIELD CURVE AND THE COMPRESSIVE STRENGTH OF POLYCRYSTALLINE GRAPHITE. R. L. Woolley (Berkeley Nuclear Labs., Gloucestershire, Eng.). Phil. Mag. (8), 11: 799-807(Apr. 1965).

The form of the yield curve of polycrystalline graphite and the value of its compressive strength are explained quantitatively in terms of dislocations associated with the sub-grain boundaries. (auth)

23054 THE COMPRESSIONS OF TERBIUM, EUROPIUM, SCANDIUM AND $MnSn_2$ TO HIGH PRESSURES BELOW 300°K. C. E. Monfort, III and C. A. Swenson (Ames Lab., Ames, Iowa). Phys. Chem. Solids, 26: 623-9(Mar. 1965). (IS-915)

Experimental data are given for the compressions of Tb metal to 24 kbars from 200 to 20°K, for Sc metal to 20 kbars from 300 to 77°K, for Eu metal to 20 kbars from 300 to 20°K, and for $MnSn_2$ to 14 kbars from 300 to 86°K. The effects of magnetic ordering are evident for both Tb and $MnSn_2$, with Tb becoming rapidly more incompressible and $MnSn_2$ becoming rapidly more compressible as the temperature is decreased below 200°K in each case. One interpretation of the terbium data yields the pressure dependences of the magnetic transition temperatures (the Neél and Curie temperatures) as $dT_N/dP = -dT_C/dP = 0.7$ (±0.3)°K/kbar. The room temperature compressibilities for Tb, Sc, and Eu (2.5, 2.3 and 8.45×10^{-6} bar^{-1}, respectively), as well as the total compressions, are in disagreement with other published data. The equation of state of Eu metal shows no gross effects which could be ascribed to the magnetic ordering. (auth)

23055 THE FORCED MAGNETOSTRICTION OF SINGLE-CRYSTAL GADOLINIUM. W. E. Coleman and

A. S. Pavlovic (West Virginia Univ., Morgantown). Phys. Chem. Solids, 26: 691-6(Apr. 1965). (TID-21259)

The magnetostriction of gadolinium single crystals was measured in magnetic fields up to 20 kOe over temperatures ranging from 77°K through the Curie temperature. The magnetic field dependence of the exchange magnetostriction was found to obey the relation, $\lambda = AH^n + B$. The value for n was determined as a function of temperature. By analyzing the field dependence of the anisotropic magnetostriction, it was possible to separate the forced exchange magnetostriction and the anisotropic forced magnetostriction. The anisotropic volume magnetostriction and the forced anisotropic volume magnetostriction were also determined. (auth)

23056 LATTICE DYNAMICS, HEAT CAPACITIES, AND DEBYE-WALLER FACTORS FOR Be AND Zn USING A MODIFIED AXIALLY SYMMETRIC MODEL. R. E. DeWames, T. Wolfram, and G. W. Lehman (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev., 138: A717-28(May 3, 1965).

It is noted that the total energy of the electron-ion system in the metallic state arises from an electron self-energy term as well as volume-dependent pairwise interaction terms among the ions. The Slutsky-Garland model used by Schmunk et al. to analyze the experimental dispersion curves of Be does not give the proper elastic behavior. The experimental dispersion curves for beryllium and zinc measured by Schmunk et al. and Borgonovi et al., respectively, are analyzed using a model consistent with the elastic behavior. For beryllium, the calculated dispersion curves agree well with the neutron inelastic-scattering data and the elastic constants of Smith and Arbogast. For zinc, the calculated frequencies are within the experimental uncertainties with the exception of the transverse branches along the $[0\bar{1}\bar{1}0]$ direction which describes atomic motions perpendicular to the basal planes. The experimental data on Zn indicate high dispersion and fluctuations in frequency ω versus wave number q. The calculated elastic constants agree within a few percent with the experimental data of Alers and Neighbours at 300°K, with the exception of C_{44} and C_{13}, which are low by 19 and 27%, respectively. The Debye-Waller factor and the specific heat for both metals are compared with available experimental data. It is found that the calculated specific heat for zinc is in excellent agreement with experiment over the whole temperature range. However, for beryllium, the calculated values are low for small temperatures; the discrepancy could be attributed to heavy impurities in beryllium. The anisotropy in the Debye-Waller factor for zinc is in good agreement with x-ray and Mössbauer experiments. (auth)

23057 NEUTRON-DIFFRACTION INVESTIGATION OF CHROMIUM WITH SMALL ADDITIONS OF MANGANESE AND VANADIUM. Y. Hamaguchi, E. O. Wollan, and W. C. Koehler (Oak Ridge National Lab., Tenn.). Phys. Rev., 138: A737-43(May 3, 1965). (ORNL-P-846)

The magnetic properties of chromium alloys with small amounts of manganese (0.5, 0.74, and 2.1%) and vanadium (1.0 and 1.9%) were investigated by neutron diffraction, and these results and others involving higher manganese concentrations are compared with theoretical calculations by Tachiki and Nagamiya. The addition of vanadium tends first (1.0%) to destroy the long-range modulation of the moment configuration and then rapidly to eliminate the magnetic moment of the system. The addition of manganese progressively modifies the temperature-dependent properties of the modulated-moment structure of pure chromium and the temperature of the spin-flip transition. Over a small composition range both the simple antiferromagnetic and the modulated-moment structures appear to be stable. Above 2.1% manganese only the simple antiferromagnetic structure is observed. The changes in the magnetic properties of the alloys have a qualitative relation to the theoretical calculations. (auth)

23058 DISTRIBUTION OF MAGNETIC MOMENTS IN Pd-3d AND Ni-3d ALLOYS. J. W. Cable, E. O. Wollan, and W. C. Koehler (Oak Ridge National Lab., Tenn.). Phys. Rev., 138: A755-9(May 3, 1965). (ORNL-P-840)

Neutron-scattering and magnetization measurements were made on a series of face-centered cubic Pd-3d and Ni-3d alloys to determine the distribution of magnetic moments in these ferromagnetic binary alloys. The specific alloys studied were: Ni_3Co, NiCo, Pd_3Co, PdCo, Pd_3Fe (ordered and disordered), PdFe, $Pd_{0.93}Fe_{0.07}$, and $Pd_{0.97}Fe_{0.03}$. Magnetic moments of about 3.0, 1.8, and 0.6 Bohr magnetons per atom were found for Fe, Co, and Ni, respectively, and these were essentially independent of concentration. The average Pd moment varies with concentration and approaches a maximum of about 0.4 Bohr magnetons per atom in the concentrated alloys. (auth)

23059 THEORETICAL SPECIFIC HEATS OF BERYLLIUM. R. P. Gupta and B. Dayal (Banaras Hindu Univ., Banaras, India). Phys. Status Solidi, 9: 87-9(1965).

The specific heat of beryllium was calculated from the electron gas model proposed in an earlier paper. The theoretical values of c_v computed from this model are in good agreement with the experimental values. (auth)

23060 ELECTRICAL RESISTANCE MEASUREMENTS ON HYDROGEN-CHARGED TANTALUM AND NIOBIUM. M. Verani Borgucci and L. Verdini (Istituto Nazionale di Ultracustica, Rome). Phys. Status Solidi, 9: 243-50(1965).

By measuring the electrical resistance of Ta and Nb wires, it is possible to detect the effective introduction of hydrogen in these bcc metals by electrolytic charging. In both metals this process gives an increase of the electrical resistivity which, for low concentrations, at room temperature is $\Delta_{\rho H} = 0.80\ \mu\Omega$ cm/at.% hydrogen in Ta and $\Delta_{\rho H} = 0.75\ \mu\Omega$ cm/at% of hydrogen in Nb. Subsequent isochromal annealings in vacuum (10^{-4} mm Hg) shows that the hydrogen introduced by electrolytic charging is completely removed at temperatures above 800°C. This degassing process becomes important only for temperatures above 500°C for Ta and 400°C for Nb. (auth)

23061 SOME FACTORS DETERMINING TYPES OF CONSTITUTIONAL DIAGRAMS IN BINARY SYSTEMS FORMED BY REFRACTORY OXIDES. S. G. Tresvyatskii and L. M. Lopato. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 5, 35-40(1964). (In Russian)

Utilization of the differences in ionic radii and electronegativities of binary oxide systems to predict the type of constitutional diagrams (formation of solid solutions, chemical compounds, or eutectic structure of solidus-liquidus range) for refractory systems made up of BeO, MgO, CaO, SrO, BaO, and rare earth oxides is recommended. A chart of different values in ion radii and electronegativities of BeO, MgO, CaO, SrO, BaO, and the rare earth oxides including La_2O_3, Ce_2O_3, Pr_2O_3, Nd_2O_3, Sm_2O_3, Eu_2O_3, Gd_2O_3, Tb_2O_3, Dy_2O_3, Y_2O_3, Ho_2O_3, Er_2O_3, Yb_2O_3, Tm_2O_3, and Sc_2O_3 is given. (Rev. Metal Lit., 22: (Feb. 1965))

23062 TIME HARDNESS OF TUNGSTEN. V. A. Borisenko. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 5, 47-8(1964). (In Russian)

The time hardness of work-hardened tungsten was tested by impression of a sapphire pyramid at constant load, at 20, 940, and 1310°C, for periods from 10 sec to 1 hr. Curves were plotted for deformation rates (hardness) during various segments of time for the three selected temperature points. (auth)

23063 PHASE EQUILIBRIA IN THE SYSTEM Zr–W–C. Yu. B. Kuzma, T. F. Fedorov, and E. A. Shvets (L'vov State Univ. and Baikov Inst. of Metallurgy, USSR). Poroshkovaya Met., Akad. Nauk Urk. SSR, No. 2, 22-6(Feb. 1965). (In Russian)

The system Zr–W–C was investigated by means of x-ray and microstructure analyses. The phase equilibria were established in the cast systems and at 1500°C. The solid solution of ZrC was as high as 34 mol % WC at 1500°C and 40 mol % WC at 1950°C. In the cast systems with contents of 2 to 10 at. % Zr, 40 to 48 at. % W, and 50 at. % C

the ω-phase with a crystal structure of the NaCl type (a = 4.25 to 4.30 Å) was found. (auth)

23064 THERMODYNAMIC STABILITY MONOCARBIDES OF TRANSIENT METALS OF SUBGROUPS IV-VI. R. G. Avarbe. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 2, 41-9(Feb. 1965). (In Russian)

An analysis was made of the data in the literature on the state diagrams in systems of the transient metal of subgroups IV–VI with carbon by the dependence of the heats of formation, energies of automation, and coefficients of activity of monocarbide phases on the position of the metal in the periodic system, as well as data on evaporability. (auth)

23065 ON THE CONNECTION BETWEEN THE HARDNESS AND STRENGTH OF TUNGSTEN AND MOLYBDENUM OVER A WIDE RANGE OF TEMPERATURE. V. A. Borisenko. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 2, 57-9(Feb. 1965). (In Russian)

The relation between hardness and ultimate strength was generalized on the basis of known experimental dependences. It is shown that the ratio of the ultimate strength and hardness also obeys an exponential dependence. The experimental data corroborated this conclusion. (auth)

23066 PHASE EQUILIBRIA IN THE SYSTEM ZIRCONIUM–MOLYBDENUM–CARBON. T. F. Fedorov, Y. B. Kuzma, and L. V. Gorshkova. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 3, 69-74(Mar. 1965). (In Russian)

The system Zr–Mo–C was investigated by means of x-ray and microstructure analyses. The phase equilibria were established at 1400 and 600°C. The compound Mo_2C dissolved approximately 4 at.% Zr; the solid solution on a ZrC base reached 90 mole % Mo_3C_2. The hexagonal phase Mo_3C_2 could be stabilized at 1400°C and below by zirconium. (auth)

23067 PHASE EQUILIBRIA IN THE SYSTEM ZIRCONIUM–CHROMIUM–CARBON. T. F. Fedorov and Y. B. Kuzma. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 3, 75-9(Mar. 1965). (In Russian)

The Zr–Cr–C system was investigated by means of x-ray and microstructure analyses. The phase equilibria were established at 1300°C. The compound ZrC dissolved approximately 6 at.% Cr; the chromium carbides did not dissolve zirconium. In accordance with the thermodynamical data the ZrC phase was found to be in equilibrium with chromium carbides, chromium, and $ZrCr_2$. (auth)

23068 THE MAGNETIC SUSCEPTIBILITY OF THE GADOLINIUM—LUTETIUM ALLOY SYSTEM. J. Popplewell, A. M. Harris, and R. S. Tebble (Univ. of Sheffield, Eng.). Proc. Phys. Soc. (London), 85: 347-9(Feb. 1965).

The magnetic susceptibility χ was measured for alloys containing 90.2%, 80.6%, 69.4%, 57.2%, 47.6%, 34.6%, 20.2%, 15%, and 8.3% gadolinium in lutetium. These measurements enabled the Curie temperature and magnetic moment p_{eff} of the alloys to be determined. Only the 20.2% Gd alloy shows any departure from the Curie–Weiss behavior, and this is attributed to the onset of antiferromagnetic ordering. (auth)

23069 PRODUCTION OF URANIUM, THORIUM, AND PLUTONIUM AND THEIR COMPOUNDS. Reactor Fuel Process., 8: No. 1, 50-64(Winter 1964-65).

A review is presented on the preparation and properties of uranium and thorium compounds, including oxides, phosphides, nitrides, fluorides, and carbides for use as reactor fuels in some cases. 61 references are included. (P.C.H.)

23070 METALS FOR CRYOGENIC APPLICATIONS. Pierre Vachet. Rev. Aluminium, 41: 1283-97(Dec. 1964). (In French)

The construction of devices for very low-temperature operation makes it necessary to use metals with a ductile-brittle transition point no lower than the operation temperature. It seemed that the cubic face-centered metals offer the highest performance in this respect. Steel, aluminum alloys, titanium alloys, copper alloys, and nickel alloys were considered. Among the steels, ferritic steels with 9% Ni and austenitic steels could be used safely down to the lowest temperatures. Among the Al alloys, Al–Mg alloys were found to be preferable. The titanium alloys were principally used for rocket tanks, and nickel alloys could also be used for this purpose. As a rule, the mechanical resistance was not the only characteristic to be considered; corrosion and chemical behavior must also be taken into account. (auth)

23071 STATISTICAL MODELS FOR THE INTERPRETATION OF IMMISCIBILITY IN MELTED SILICATES. S. Lungu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 895-910(1964). (In French)

A "configuration" immiscibility model is described for systems where the immiscibility appears by attributing to some configurations, corresponding to transition compositions, a positive energy. The calculation was made by the Kikuki-Hijmans-de Boer method. For a polyhedron lattice of the type of silica, with a base figure formed by 5 polyhedrons, one central and the other four connected to it and not directly bound among themselves, an immiscibility curve was obtained for the SiO_2–ThO_2 system, similar to that obtained experimentally and to those known for the SiO_2–$RO_{1.5}$ systems (R = La, Sm, Yb, and Y). For a polyhedron lattice of the same type as that of UO_2, with a base figure formed by 4 polyhedrons, connected to each other along the sides of a tetrahedron, an immiscibility curve similar to that determined experimentally for a SiO_2–UO_2 system was obtained. (tr-auth)

23072 INVESTIGATION OF ELECTRIC CONDUCTIVITY OF TANTALUM PENTOXIDE IN THE 200-600°C TEMPERATURE RANGE. Z. Sokalski and Z. Czarny (Inst. of Tech., Gliwice, Poland). Roczniki Chem., 39: 299-307 (1965). (In Polish)

The electric conductivity of a tablet of polycrystalline Ta_2O_5 in an atmosphere of various gases in the pressure range of 1 atm to 10^{-5} mm Hg and a temperature range of 200 to 600°C was studied. It was found that in this range conductivity attains values from 10^{-11} to 10^{-6} Ω^{-1} cm^{-1} and depends in a large extent on the quality and pressure of the gas. Notwithstanding what gas was used, a pressure increase always caused an increase of conductivity. Changes in conductivity occurred within some minutes and followed the shape of isotherms. The range of pressures in which an essential increase or drop of conductivity was observed was 10^{-1} to 100 mm Hg. The data and the σ_0 and E values calculated by the formula $\sigma = \sigma_0 e^{-E/2kT}$ showed that Ta_2O_5 conductivity in the range of temperature studied by the measurements described is of surface character for higher pressuures and of the character of an admixture for low pressures of a gas. (auth)

23073 CREEP OF WC–Co POWDER-METAL HARD ALLOYS. G. S. Kreymer, N. A. Alekseyeva and A. I. Baranov. Sb. Tr., Vses. Nauchn.-Issled. Inst. Tverd. Splavov, No. 5, 182-8(1964).

Studies were made on the creep of alloy VK6 (6% Co + 94% WC) during fixed-point bending at 800°C in relation to grain size of the WC and magnitude of stress. Samples were bars measuring 5 × 5 × 35 mm. Creep of WC–Co alloys occurred during the first two stages in the same manner as that of a homogeneous metal, which is apparently related to the fact that the process is governed by the creep of Co. The creep rate during bending of the WC–Co alloy in the steady creep range agrees with the predictions of J. Weertman's theory. The deformation-time curve in the unsteady creep range is the same for bending and tension. (Referativnyy Zhurnal, Metallurgiya, No. 10, Oct. 1964)

23074 HABIT OF GRAPHITE CRYSTALS. A. A. Baranov (Dnepropetrovsk Metallurgical Inst., Ukrainian SSR). Soviet Phys.-Cryst. (English Transl.), 9: 644-6 (Mar.-Apr. 1965). Translated from Kristallografiya, 9: 759-62(Sept.-Oct. 1964).

The transverse growth of graphite (increase in the number of basal planes) was distinguished from the longitudinal growth (growth of the basal planes). Anisotropy in crystal growth was observed on ground and polished surfaces of commercial iron containing modular graphite and Ni–C and Co–C systems. The presence of surface defects and intersections of dislocation lines with the outer surface of the sample facilitated graphite growth. The effects of supersaturation and cooling rate on graphite growth were determined. (M.C.G.)

23075 THERMOEMISSION CHARACTERISTICS OF ISOMORPHOUS CARBIDE ALLOYS. G. V. Samsonov, V. S. Fomenko, V. N. Paderno, and B. M. Rud' (Inst. of Material Research Problems, Academy of Sciences, USSR). Teplofiz. Vysokikh Temp., 2: 730-5(1964).

A method for the preparation of homogeneous alloys of different composition and for obtaining compact tablets of isomorphous alloys of TaC–ZrC, TaC–HfC, and HfC–NbC was developed. The thermoemission characteristics of these alloys and their dependence on the concentration were studied in the temperature range of 1100-2500°C. The tablets were pressed at 2500-2700°C over a period of 5 minutes under a pressure of 300 kg/cm^2, and were ground and polished to 6 mm in diameter and 0.6-0.7 mm in height. Their residual porosity did not exceed 5-9%. Temperatures were measured with a micropyrometer OMP-19A. It was found that the thermoemission characteristics of these alloys depended on the electron shell structure of the constituent metal atoms. The work functions of the alloys were found to be higher than the work functions of the individual carbides because of the strong interactions between the metal atoms. The nature of variation of the thermoemission characteristics of carbide solid solutions was determined from the relationship between the acceptor capacity of the metal atoms and the probability of having a d^5 type electron configuration. (CFSTI)

23076 EFFECTIVE HEAT CONDUCTIVITY AND EMISSIVITY OF OXIDATION-RESISTANT, CERAMIC, FLAME-SPRAYED, REFRACTORY-OXIDE COATINGS. A. G. Boganov, Yu. A. Pirogov, and L. P. Makarov. Teplofiz. Vysokikh Temp., 3: 64-9(1965).

An investigation was made of the effective thermal conductivity and total emissivity of several refractory oxide coatings 0.55 to 0.7 mm thick. Aluminum oxide, stabilized zirconium oxide, zircon, titanium dioxide, alumino-magnesia spinel, and chromium oxide were flame sprayed on steel substrates. The themal conductivity was measured in a vacuum of 1×10^{-5} mm Hg or in argon at a pressure varying from 10 to 700 mm Hg in the 300 to 900°C range. All coatings had a very low effective thermal conductivity, which increased with increasing argon pressure and test temperature. The thermal conductivity was, on the average, 5 to 10 times lower than in solid materials with a 20 to 30% porosity. This was explained by the fact that in the flame-sprayed coatings there was no continuous contact between the coating and the substrate and between individual particles of the coating. This, and the low thermal conductivity of the gas layer in the coating pores, are the two main causes of the low effective thermal conductivity. The total heat emissivity was measured on coatings 0.1 to 0.2 mm thick, flame sprayed on a thin-walled stainless steel cylinder 18 mm in diameter and 190 mm long. Results of measurements made at temperatures up to 1200°C showed that zirconium dioxide had the highest and chromium oxide the lowest total heat emissivity. (CFSTI)

23077 THE NIOBIUM (COLUMBIUM)–ZINC SYSTEM. R. A. Meussner and R. J. Goode (Naval Research Lab., Washington, D. C.). Trans. Met. Soc., AIME, 233: 661-71 (Apr. 1965).

Six intermediate phases occur in the Nb–Zn system: NbZn, $NbZn_{1.8}$ (hex.), $NbZn_2$ (hex., $MgNi_2$ type), $NbZn_3$ (cubic, $AuCu_3$ type), $NbZn_7$, and $NbZn_{15}$. These phases form by peritectic reactions at 1120, 1114, 1054, 1034, 478, and 418 to 429°C, respectively. The $NbZn_{15}$ phase appears as the minor phase in the eutectic structure, and the terminal phases remain nearly pure niobium and zinc even at high temperature. Vapor-pressure measurements on the four high-temperature phases (NbZn to $NbZn_3$) permitted estimates of the composition limits of these phases and the calculation of approximate values of ΔF^0, ΔH^0, and ΔS^0. (auth)

23078 ROLE OF GRAIN BOUNDARIES IN THE DUCTILE-BRITTLE TRANSITION BEHAVIOR OF Bcc REFRACTORY METALS. C. L. Meyers, Jr. (Aerojet-General Corp., Santa Barbara, Calif.), G. Y. Onoda, Jr., A. V. Levy, and R. J. Kotfila. Trans. Met. Soc. AIME, 233: 720-8(Apr. 1965).

The hypothesis that solid-solution hardening of regions in the order of tens of angstroms thick along grain boundaries is the most important mechanism controlling the ductile-brittle transition behavior of polycrystalline bcc refractory metals is discussed. A physical model was developed and a general equation derived to describe the dependence of the solute concentration at grain boundaries on temperature, nominal impurity concentration, thermal treatments, grain size, and prior plastic deformation. Analytical curves of the solute concentration at grain boundaries vs temperature, calculated by means of the derived equation, were found to have the same general form as curves of ductility vs temperature plotted from experimental data. Semiquantitative relationships between the transition temperature and metallurgical variables can be determined by using the physical model. (auth)

23079 SIZE-FACTOR LIMITATION IN A_6B_{23}-TYPE COMPOUNDS DUE TO THE "ENVELOPING EFFECTS"; NEW COMPOUNDS BETWEEN MANGANESE AND THE LANTHANIDE ELEMENTS. Frederick E. Wang and James R. Holden (Naval Ordnance Lab., Silver Springs, Md.). Trans. Met. Soc. AIME, 233: 731-6(Apr. 1965).

Through both single-crystal and powder x-ray diffraction methods, ten A_6B_{23}-type compounds were confirmed to exist between lanthanides (A) (plus scandium and yttrium) and manganese (B); A = Y, Nd, Sm, Gd, Tb, Dy, Ho, Er, Tm, and Lu. The formation of a compound of this type is shown to be extremely sensitive to atomic size; hence it can be classified as a "size-factor" compound. The "enveloping effect", a geometrical consideration observed in its crystal structure, is proposed as the reason for the A_6B_{23}-type compound being size-sensitive. The approximate ideal geometrical ratio of the radii R/r is 1.31 while experimentally A_6B_{23}-type compounds have a radius ratio lying within the range 1.2 to 1.4. (auth)

23080 THE COLUMBIUM–HYDROGEN CONSTITUTION DIAGRAM. R. J. Walter and W. T. Chandler (Rocketdyne, Canoga Park, Calif.). Trans. Met. Soc. AIME, 233: 762-5(Apr. 1965).

The Nb–H phase diagram was determined for hydrogen concentrations up to $NbH_{0.9}$ at temperatures below 400°F. The phase diagram includes a miscibility gap and a eutectoid transformation. A peritectoid transformation is postulated at the hydrogen-rich end of the diagram. Phase diagrams were determined for two levels of purity of the niobium. (auth)

23081 THE OCCURRENCE OF CYLINDRICAL TEXTURE IN TUNGSTEN WIRES. G. D. Rieck and A. S. Koster (Technical Univ., Eindhoven, Netherlands). Trans. Met. Soc. AIME, 233: 770-2(Apr. 1965).

X-ray experiments were carried out to show the occurrence of cylindrical texture in drawn tungsten wire. Only a small amount of {110} ⟨110⟩ cylindrical texture could be found in wires of intermediate thickness, i.e., of about 1.5 mm diameter. (auth)

23082 FRACTURE OF ZIRCONIUM AND ZIRCONIUM-HYDROGEN ALLOYS. C. J. Beevers (Berkeley Nuclear Labs., Gloucestershire, Eng.). Trans. Met. Soc. AIME, 233: 780-6(Apr. 1965).

The influence of zirconium hydride precipitate morphology on the fracture of Zr–H systems tested at strain rates of 10^{-4} sec^{-1} at 20 and –196°C and at strain rates of ≈500 sec^{-1} at 20°C was investigated. The critical stage in the embrittlement of these systems was the fracture of the zirconium hydride precipitates to form large internal cracks at a stress of 25,000 to 27,000 psi. In specimens containing up to 100 ppm H the precipitates existed as iso-

lited platelets in the zirconium matrix and their fracture was enhanced by low temperature (−196°C) and high strain rate (≈500 sec^{-1}) loading. These results lead to the conclusion that the rate of strain hardening of the zirconium metal controls the fracture of the hydride platelets. Increased hydrogen contents of 500 to 2000 ppm resulted in an increase in the volume fraction and size of precipitates and also led to crack propagation in the hydride at both 20 and −196°C at the low strain rates (10^{-4} sec^{-1}). Quenching led to refinement of hydride precipitate size and reduced the degree of embrittlement at −196°C; this effect is attributed to the absence of fracture of the fine precipitates. (auth)

23083 PHASE RELATIONS AND THERMODYNAMIC PROPERTIES FOR THE CERIUM−ZINC SYSTEMS. P. Chiotti and J. T. Mason (Ames Lab., Ames, Iowa). Trans. Met. Soc. AIME, 233: 786-95(Apr. 1965).

Metallographic, thermal, x-ray, and vapor-pressure data were employed in establishing the Ce−Zn phase diagram. Nine compounds and three eutectics were observed. The eutectic compositions in weight percent zinc and temperatures were 10% and 495°C, 37% and 795°C, and 56% and 810°C. Three of the compounds, CeZn, $CeZn_2$, and $CeZn_{8.5}$, melted congruently at 825, 875, and 980°C, respectively; the other six compounds, $CeZn_3$, $CeZn_{3.67}$, $CeZn_{4.8}$, $CeZn_{5.25}$, $CeZn_7$, and $CeZn_{11}$, decomposed peritectically at 820, 840, 870, 885, 960, and 795°C, respectively. The compound $CeZn_{5.25}$ was an AB_5 type with a small range of composition, which lay on the zinc-rich side of the 1 to 5 stoichiometry. Zinc vapor-pressure data obtained by the dewpoint method were employed in calculating the thermodynamic properties of both the liquid alloys and solid compounds. The data for the liquid alloys were fitted to the relation $\Delta\overline{F}^{xs}_{Zn} = N^2_{Ce}(c + dN^{4.8}_{Zn})$, from which the relation $\Delta\overline{F}^{xs}_{Ce} = N^2_{Zn}[c + dN^{4.8}_{Zn}(N_{Zn} - 0.737)]$ was obtained by integration. In these relations $\Delta\overline{F}^{xs}$ is the excess partial molal free energy, N is atom fraction, and the constants c and d have the values c = (−22,000 + 7.0 T) and d = (−171,000 + 74.0 T). Relations for the standard free energy of formation for the solid compounds were derived from the data. At 973°K the enthalpy in kilocalories per gram-atom varied from −11.3 for $CeZn_2$ to −8.21 for $CeZn_{11}$ and the free energy in the same units varied from −7.1 for $CeZn_2$ to −3.82 for $CeZn_{11}$. (auth)

23084 DEFORMATION IN PYROLYTIC GRAPHITE. William V. Kotlensky (California Inst. of Tech., Pasadena). Trans. Met. Soc. AIME, 233: 830-2(Apr. 1965).

Additional evidence is presented for two distinct stages in the deformation of pyrolytic graphite. The first region in deformation up to approximately 15% elongation describes the first or dewrinkling stage. Over this region the percent thickness change (decrease) is approximately equal to the percent deformation, but the width increases slightly. Nonbasal plane slip, mass transport due to Nabarro-Herring creep, and slip along misoriented basal planes are suggested as mechanisms for the second stage deformation. (M.C.G.)

23085 PRECIPITATION OF Mo_2C ON A FREE SURFACE. C. N. Reid (Birmingham Univ., Eng.). Trans. Met. Soc. AIME, 233: 834-6(Apr. 1965).

In the course of annealing studies on molybdenum it was observed that a carbide precipitates preferentially on internal and external surfaces. (M.C.G.)

23086 ORIENTATION EFFECTS IN THE DEFORMATION OF MOLYBDENUM CRYSTALS. D. L. Davidson and F. R. Brotzen (Rice Univ., Houston, Tex.). Trans. Met. Soc. AIME, 233: 838-9(Apr. 1965).

Orientation effects and glide systems in zone-refined molybdenum single crystals deformed in tension and in direct shear were studied. It was found that the primary slip system is $\{110\}\langle 111\rangle$ for direct shear at room temperature. The shear stress on the (123) was lower than that on the (112). It was also found that slip occurs on the (110) $[1\bar{1}1]$ system having the greatest resolved shear stress. The activation volume was found to decrease with strain at all temperatures, orientations, and strain rates investigated. It was concluded that the plastic deformation mechanisms in molybdenum at room temperature are orientation dependent and involve interactions affected by the stress state. (M.C.G.)

23087 EFFECTS OF CONTAMINANTS ON THE THERMAL EXPANSION OF TANTALUM. J. B. Conway, R. M. Fincel, Jr., and A. C. Losekamp (General Electric Co., Cincinnati). Trans. Met. Soc. AIME, 233: 841-2(Apr. 1965).

Effects of impurity absorption from helium atmosphere on linear thermal expansion of arc-cast tantalum were determined. The sample began absorbing impurities at temperatures above 1000°C. Data are shown in graphs. (M.C.G.)

23088 THE LINEAR THERMAL EXPANSION OF NIOBIUM (COLUMBIUM). J. B. Conway, R. M. Fincel, Jr., and A. C. Losekamp (General Electric Co., Cincinnati). Trans. Met. Soc. AIME, 233: 844-5(Apr. 1965).

The effects of impurities absorbed from the helium atmosphere on the linear thermal expansion of arc-cast niobium were determined. In the presence of specimen contamination the heating and cooling curves were not coincident and the specimen did not return to its original dimensions. (M.C.G.)

23089 ALLOYS OF THE Ti−Al−Mo−Fe SYSTEM. A. I. Khorev and V. N. Moiseev. Tsvetn. Metal., No. 1, 84-9(Jan. 1965).

Studies were made on the possibility of adding molybdenum to titanium alloy VT14 in the form of ferromolybdenum while maintaining the level of mechanical and engineering properties of the alloy. Phase transformations taking place for alloys with varying iron and molybdenum content when quenched from different temperatures are described. It was established that the content of iron and molybdenum is a critical factor in producing a stable microstructure as well as the quench temperature for critical concentrations of these elements. Increasing the iron and molybdenum content to the proper concentration improved weld joint strength in the heat treated state. For alloys with 2-3% (2.5% Mo) a weld joint tensile strength of 120-130 kG/mm^2 was obtained. Analysis of the results of investigations on the mechanical and engineering properties of alloys in the Ti−Al−Mo−Fe system showed that proper selection of composition will provide properties similar to those of VT14. Mo and Fe concentrations are graphically presented along with a table that gives the results of testing weld joints for bend angle and tensile strength in comparison with the base metal. All studies were made with a constant aluminum content (4%). (CFSTI)

23090 EFFECT OF EXPOSED TIME AT ELEVATED TEMPERATURE ON THE EMBRITTLEMENT OF WELDED JOINTS OF HT 60 STEEL FOR NUCLEAR PRESSURE VESSELS. Michio Inagaki and Haruyoshi Suzuki (National Research Inst. for Metals, Japan). Yosetsu Gakkaishi, 33: 1010-19(Nov. 1964). (In Japanese)

The effects of exposure at 550°C for times up to 5,000 hr on the notch ductility and the microstructure change of welded joints of Ni−Cr−Mo type HT60 tempered steel were investigated. Test steel, 100 mm thick, was produced experimentally for nuclear pressure vessels and welded joints were made by electroslag welding and CO_2 arc welding. The results of the study indicated that the base metal, the weld metal, and the heat-affected zone (HAZ) of base metal exposed at 550°C for times up to 5,000 hr tended to embrittle owing to the grain growth of ferrite and the cohering of carbide toward grain boundaries. This process of change in microstructure may be divided into the following three stages: (I) tempering of martensite and spheroidizing of carbide, (II) formation of fine ferrite, and (III) grain growth of ferrite and cohering and coarsening of carbide toward grain boundaries. The change in microstructure for the base metal occurs with state III only; the HAZ with electroslag welding stages II → III; the HAZ with CO_2 arc welding stages I → II → III. (auth)

23091 MEASUREMENTS OF VAPOR PRESSURES OF BINARY AMALGAMS. Gerhard Jangg and Franz Steppan

(Technische Hochschule, Vienna). Z. Metallk., 56: 172-8 (Mar. 1965). (In German)

Measurements were made, on different amalgams, of vapor pressure vs. temperature at constant composition and of vapor pressure changes during isothermal decomposition. The ranges of composition of various mercury compounds and their thermodynamical data could be determined. The existence of the compounds $NiHg_4$, MnHg, and Mn_2Hg_5, and $PtHg_4$ could be corroborated. $PtHg_2$ and PtHg were found to disproportionate at 240 and 180°C, respectively. The existence of the compounds UHg_4, UHg_3, and UHg_2 was corroborated; their heats of formation were found at variance with those given in literature. A phase, $ThHg_2$, was found, which exhibited a particularly high heat of formation as did $ThHg_3$ and ThHg. (auth)

23092 INVESTIGATIONS ON SOME METAL POWDERS USED IN THE MANUFACTURE OF SINTERED CONTACT MATERIALS. Bernhard Althaus and Carl-Ludwig Meyer (E. Durrwachter-Doduco-KG, Pforzheim, Ger.). Z. Metallk., 56: 182-6(Mar. 1965). (In German)

Four different types of tungsten powder and one type of tungsten carbide powder were investigated with regard to their behavior during compacting at 1 to 6 Mp/cm^2 and sintering at 1300°C. The compactibility and the compressive strength of cylindrical compacts and of the sintered and the silver impregnated skeletons were measured. Milled coarse tungsten powder gave the highest compactibility and strength of the compacts, tungsten carbide the lowest. However, the finest powders gave the highest compressive strength to sintered skeletons because of the large number of contacting points. The infiltrated materials reached far higher and nearly similar strength with all powders. (auth)

23093 EFFECT OF UNIFORM COMPRESSION ON THE MAGNETIZATION OF DYSPROSIUM AND TERBIUM. L. I. Vinokurova and E. I. Kondorskii (Moscow State Univ.). Zh. Zksperim. i Teor. Fiz., 48: 429-36(Feb. 1965). (In Russian)

The effect of pressure on the magnetization of polycrystalline samples of dysprosium whose magnetic structure at $H < H_k$ is antiferromagnetic and on the magnetization of terbium in the ferromagnetic state was investigated. The measurements were carried out in magnetic fields up to 17 kOe. Extreme values of the effect were found in the field-dependence curves of the pressure coefficient $(\Delta\psi/\psi)/p$ in dysprosium. The held strength values H_k' corresponding to the extreme values of $(\Delta\psi/\psi)/p$ grow with increase of the temperature in the interval $146.5°K < T < 169.3°K$ and then decrease. Passage through this temperature range involves a change of the sign of $(\Delta\psi/\psi)/p$ for $H \leq H_k'$ (at $T \leq 145°K$ the effect is negative and at $T \geq 169.3°K$ it is positive). The appearance of maxima and minima in the effect upon transition from the antiferromagnetic to the ferromagnetic state and the change in the sign of $(\Delta\psi/\psi)/p$ near the Néel point for $H \leq H_k'$ can be explained by the effect of pressure on the magnetic anisotropy constants. It is found that uniform compression decreases the magnetization of terbium. In weak fields ($H < 10$ kOe) the pressure coefficient $(\Delta\psi/\psi)/p$ is large ($\sim 10^{-4}$) and changes with the pressure. At H = 17 kOe the pressure coefficient is constant and independent of temperature throughout the complete range of temperatures from 77 to 169°K. It is suggested that the observed decrease of magnetization in strong fields is connected with a change in the magnitude of the exchange interaction integrals during uniform compression. (auth)

23094 GENERALIZED CORRELATION BETWEEN THE TEMPERATURES AND HEATS OF FIRST ORDER PHASE TRANSITIONS FOR PURE METALS. I. Z. Kopp (Inst. of Boiler and Turbine Construction, Leningrad). Zh. Fiz. Khim., 39: 360-3(Feb. 1965). (In Russian)

The empirical Trouton's rule for the relation between the heats and temperatures of vaporization and Richard's rule for the relation between the heats of melting and the melting points appreciably deviate from the accumulated experimental data on the temperatures and heats of phase transition for pure metals. Generalization of the isolated and rather contradictory experimental and theoretical values for the heats and temperatures of first order phase transitions of metals showed that they may be satisfactorily correlated by generalized equations of the type, $r_{1r} = BT_{tr}^{n}$, where for melting, B = 0.737 and n = 1.14 and, for boiling, B = 1.93 and n = 1.33. (auth)

23095 PROPERTIES OF GADOLINIUM BERYLLIDES. A. A. Kruglykh, N. N. Matynshenko, V. S. Pavlov, and G. F. Tikhinskii (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Neorgan. Khim., 10: 285-7 (Jan. 1965). (In Russian)

In the Be–Gd system, the existence of the beryllide with the composition $GdBe_{13}$ was established. It has a cubic lattice with the parameter $\underline{a} = 10.271 \pm 0.005$ Å. It was found that the intermetallic compound dissociates above 1050°C. The velocity of the vaporization of the beryllides by dissociation of the compound $GdBe_{13}$ was measured. The equation for determination of the pressure of beryllides above compounds from their dissociation was calculated for the temperature interval 1055 to 1250°C. (tr-auth)

23096 CRYSTAL STRUCTURES OF SOME TERNARY COMPOUNDS IN THE Nb–Co–Si SYSTEM. Yu. Kuz'ma, E. I. Gladyshevskii, and D. S. Byk (Lvov State Univ.). Zh. Struckt. Khim., 5: 562-7(1964).

The ternary compounds in the Nb–Co–Si system, and in particular the compound $Nb_6Co_{16}Si_7$, were studied. Because the phase diagram of the Nb–Co system in the Nb rich region was not previously investigated, alloys of Nb and Co containing from 33 to 90 atom % of Nb were investigated. The system was prepared from powders of the following purities: Nb, 99.3%; Co, 99.26%; and Si, 99.99%. Each batch was thoroughly mixed and pressed into cylindrical specimens, which were melted in aluminum crucibles in a hydrogen atmosphere by means of an induction furnace. X-ray structural analysis was conducted by the powder method using chromium radiation and 57.3-mm dia camera. The lattice constant of compounds were determined by photographing the reciprocal lattice using silver as a standard. Microstructural analyses were conducted with a MIM-6 microscope. A mixture of concentrated nitric and hydrofluoric acids were used for etching the specimens in order to bring out the microstructure. The x-ray pattern of the homogeneous Nb_3Co_2Si compound was indexed as the face-centered cubic lattice. The lattice constant a equaled 11.196 ± 0.003 Å. The structural symmetry composition and the magnitude of the lattice constant indicated the possibility of structure of the Mn_3Ni_2Si type. The calculated and observed intensities were in good agreement indicating the structure. The x-ray pattern of the almost homogeneous Nb_2Co_2Si compound was indexed on hexagonal syngony when c/a = 1.62. The space group $P6_3/mmcD_{6h}^4$ was indicated, which includes $MgZn_2$ type structure and its superstructure Mg_2Cu_3Si. Precise determination of lattice constants yielded a = 4.794 ± 0.002, c = 7.760 ± 0.003 Å, and c/a 1.619. Mg_2Cu_3Si-type structure of Nb_2Co_3Si (λ_1 phase) was indicated by intensity calculations. It was found that $Nb_6Co_{16}Si_7$ has a structure of the type $Mg_6Cu_{16}Si_7$ with the following parameters: $x_e = 0.192$, $xf = 0.168$ and $xf_2 = 0.377$. (CFSTI)

23097 X-RAY STUDIES OF LANTHANUM TELLURIDE La_4Te_7. A. A. Eliseev, V. G. Kuznetsov, E. I. Yarembash, and L. I. Antonova (Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Strukt. Khim., 5: 640-1(1964).

Lanthanum telluride is a compound of variable composition with a homogeneity region of $La_4Te_{6.84}$ to $La_4Te_{7.0}$, which is formed upon direct reaction of lanthanum and tellurium. A powder diffraction study was carried out on polycrystalline La_4Te_7. Its composition was verified by chemical analysis. X-ray diffraction patterns were taken at 24 ± 0.5°C and measured with accuracy of +0.03 mm. Line intensity was evaluated visually on a ten division scale. Diffraction patterns of lanthanum tellurides of the compositions, La_2Te_3, La_4Te_7, and $LaTe_2$, are discussed. The x-ray patterns of the former two compounds differ significantly from each other. X-ray patterns of La_4Te_7 and $LaTe_2$ are similar in line distribution and intensity.

The splitting of lines on the La_4Te_7 x-ray pattern results from the lowering of crystal lattice symmetry. X-ray structural investigations of $LaTe_3$ single crystals established that they belong to the P4/nmm space group and that unit cell parameters are: a = 4.557, c = 9.176 Å, c/a = 2.014, N = 2, $d_{measured}$ = 6.82 g/cm³. The described material allowed the conclusion that the structure of $LaTe_2$ is close to that of La_4Te_7. (CFSTI)

23098 ELECTRICAL CONDUCTIVITY OF GRAPHITE. K. Sugihara and Shusuke Ono (Matsushita Electric Industry Co., Ltd., Kadoma, Japan). Session I, Paper 2 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

By using calculations of conductivity in the degenerate region, electron-phonon coupling constants of graphite were determined with consideration for Umklapp collisions. In terms of these constants calculations were performed of the electric resistivity in the non-degenerate region and the Hall effect at weak field limit. The resistivity was calculated on the basis of three assumptions: interband transitions between E_3 and E_1 or E_2 bands may be neglected, scattering processes are elastic, and phonon distributions are classical. It was found that between 250 and 400°K contributions of holes to the conductivity are about 60% and it increases slightly with increasing temperatures. The Hall effect was calculated to be 0.072 cm³/coulomb. (M.C.G.)

23099 SPECIFIC HEAT OF GRAPHITE AT VERY LOW TEMPERATURES. Kozo Komatsu (Univ. of Osaka Prefecture, Sakai, Japan). Session I, Paper 5 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

Calculations were made of the specific heat of graphite at 0.4 to 2.0°K in terms of the values of inter-layer spacing, degree of stacking faults, and density. Results for numerical calculations of the atomic heat of graphite were in good agreement with experimental results. (M.C.G.)

23100 THE EFFECT OF RADIOLYTIC CORROSION ON THE MECHANICAL PROPERTIES OF GRAPHITE. N. Hawkins and J. M. Hutcheon (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.). Session V, Paper 4 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

The relation between changes in strength, Young's modulus, and elastic strain to fracture of graphite and weight loss due to radiolytic corrosion by carbon dioxide was investigated. The results suggested that changes in the strength or modulus of graphite exposed to radiolyzed CO_2-containing gases are a unique function of the amount of carbon removed. (M.C.G.)

23101 STATISTICAL ANALYSIS OF THE MECHANICAL STRENGTH OF GRAPHITE. S. Sato (Japan Atomic Energy Research Inst., Tokyo). Session V, Paper 5 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

The application of Griffith-Weibull's theory on brittle fracture to provide a consistent explanation of the mechanical failure of graphite, based on statistical considerations, is discussed. The influence of size on mechanical strength S is expressed as $S \propto V^{-1/m}$, where V is volume and m the homogeneity factor. Results agreed fairly well with experimental values. (M.C.G.)

23102 ROOM TEMPERATURE TENSILE AND COMPRESSIONAL ELASTIC PROPERTIES OF GRAPHITE. J. T. Meers, E. J. Seldin, and T. Weng (Union Carbide Corp., Parma, Ohio). Session V, Paper 6 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

The longitudinal and transverse stress-strain curves obtained by cyclic stressing of polycrystalline graphite in tension and compression are discussed. For several graphites the initial tensile and compressive moduli were found to agree with each other and with the sonic modulus for each specimen to within about 2%. In compression tests the ratio of the transverse strain to the longitudinal strain was constant and independent of stress. The transverse stress-strain curve had the same shape as the longitudinal curve except that the strain is positive and there is a positive residual strain, which increases as the compressive stress is increased. In tension tests the ratio of the transverse strain to the longitudinal strain decreased as the stress increased. The transverse strain in tension was negative, but the residual strain was positive when the stress was removed. It was indicated that when the annealing temperature is equal to the graphitization temperature the residual strain is completely relieved and the original longitudinal and transverse stress-strain curves can be reproduced. (M.C.G.)

23103 PORE STRUCTURE OF IMPERVIOUS GRAPHITE. K. Ikeda (Yokohama National Univ., Japan) and K. Kawasoe. Session VII, Paper 3 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964, 4p.

Pore-size distributions in an impervious graphite sheath for fuel elements for a semi-homogeneous reactor were measured, using the mercury porosimeter. Gas permeability coefficients calculated from the pore-size distributions were considerably higher than the experimental value. This indicated that some pores are ineffective for gas penetration. It was found that the most effective method for obtaining impervious graphite with low gas permeability is impregnating the graphite with a resin of high carbonization and baking, then saturating the sample with a resin of low viscosity. (M.C.G.)

23104 URANIUM MONOCARBIDE AND HYPOSTOICHIOMETRIC DICARBIDE. HEAT CAPACITIES AND THERMODYNAMIC PROPERTIES FROM 5 TO 350°K. E. F. Westrum, Jr. (Univ. of Michigan, Ann Arbor), E. Suits, and H. K. Lonsdale. p.156-61 of "Advances in Thermophysical Properties at Extreme Temperatures and Pressures." New York, The American Society of Mechanical Engineers, 1965. (COO-1149-28)

Heat capacities were determined by adiabatic calorimetry on characterized massive samples of UC and $UC_{1.90}$. No thermal anomalies were observed. The data were compared by means of a Shomate plot with values taken at higher temperatures by various techniques. Values of the heat capacity (C_p), the entropy (S^0), enthalpy function $[(H^0 - H^0_0)/T]$, and free energy function $[-(G^0 - H^0_0)/T]$ at 298.15°K are: 12.11, 14.28, 7.36, 6.93, and 14.46, 16.30, 8.43, 7.87, for UC and $UC_{1.90}$, respectively, in cal/(gfm °K). (auth)

23105 URANIUM DICARBIDE AND DIURANIUM TRICARBIDE. PREPARATION AND CHEMICAL THERMODYNAMIC PROPERTIES FROM 5 TO 350°K. J. D. Farr (Los Alamos Scientific Lab., N. Mex.), W. G. Witteman, P. L. Stone, and E. F. Westrum, Jr. p.162-6 of "Advances in Thermophysical Properties at Extreme Temperatures and Pressures." New York, The American Society of Mechanical Engineers, 1965. (COO-1149-29; LA-DC-6867)

Low-temperature heat capacities of hypostoichiometric $UC_{1.94}$ and of U_2C_3 determined by adiabatic calorimetry showed a typical sigmoidal temperature dependence and no thermal anomalies. Thermodynamic properties at 298.15°K derived from these data for the heat capacity (C_p), entropy (S^0), enthalpy function $[(H^0 - H^0_0)/T]$, and Gibbs energy function $[-(G^0 - H^0_0)/T]$ are 14.52, 16.33, 8.46, 7.87, and 25.66, 32.93, 16.20, 16.73 cal/(gfm °K) for $UC_{1.94}$ and U_2C_3, respectively. (auth)

23106 ELECTRON MICROBEAM PROBE TECHNIQUES FOR STUDYING GRAIN BOUNDARIES IN POLYCRYSTALLINE CERAMICS. T. J. Gray and J. K. Zope. 17p. (CONF-641116-5)

From Conference on the Role of Grain Boundaries and Surfaces in Ceramics, Raleigh, N. C.

The techniques of electron microbeam probe surface analysis are reviewed with particular emphasis on the special problems encountered with ceramics and minerals. Some limitations are discussed and methods of overcoming these proposed. The applicability of this technique to investigation of grain boundary phenomena is emphasized, and preliminary data on the interaction between molten metals and refractories are presented. (auth)

23107 HIGH-STRENGTH FORGED BERYLLIUM FOR STRUCTURAL APPLICATIONS. L. L. Soffa and G. J. Basl (Rocketdyne, Canoga Park, Calif.). 37p. (CONF-729-21)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

High-oxide fine-grain forged beryllium was investigated for potential use in aerospace structural applications. Two pancake configuration forgings were tested for static mechanical properties, chemical composition, microstructure, and texture analysis. Average strength levels achieved in static mechanical property tests were 99,300 psi ultimate tensile strength, 76,200 psi tensile-yield strength, and 6.6% elongation. Compatibility tests to nitrogen tetroxide and monomethylhydrazine showed favorable results for use of high-strength forged beryllium for these propellants. Texture analysis of one forging showed a 10 times random population of basal planes at the peak position on the pole figure. Basal plane orientation was predominantly parallel to the forged surface of the pancake as was expected for simple upset fabrication techniques. Preliminary studies of joining characteristics were performed by low-temperature zinc brazing of fine-grain forged beryllium. Zinc-brazed beryllium test specimens showed an average strength level of 78,200 psi for four specimens. (auth)

23108 A HIGH CRITICAL CURRENT SUPERCONDUCTING TITANIUM–NIOBIUM ALLOY. J. B. Vetrano and R. W. Boom (Atomics International, Canoga Park, Calif.). 16p. (CONF-794-4).

From Magnetism Conference, Minneapolis, Nov. 1964.

The stabilization of transport current in a high-field Ti-Nb alloy by metallurgical heat treatment was investigated. Solid solution annealing of the alloy, followed by nucleation and growth of a second phase precipitate, was found to have a pronounced influence on the ability of the alloy to carry high transport current in high magnetic fields. The precipitate was most effective in the early stages of growth. Overaging resulted in reduced values of critical transport current density. Aging of a Ti–20.7 at. % Nb alloy for ¾ to 6 hr at 400°C yielded a critical current density in excess of 10^5 amp/cm^2 at 4.2°K in a 30-kG applied magnetic field. The same alloy in a solid solution condition carried less than 10^4 amp/cm^2 at the same temperature and field. The upper critical field (H_{c2}) of the aged alloy was found to be 128 kG at 1.2°K. (auth)

23109 MAGNETIZATION OF THE RARE EARTH MANGANESE COMPOUNDS R_6Mn_{23}. B. F. DeSavage, R. M. Bozorth, F. E. Wang, and E. R. Callen (Naval Ordnance Lab., White Oak, Silver Spring, Md.). 9p. (CONF-794-9)

From Magnetism Conference, Minneapolis, Nov. 1964.

Measurements were made of the magnetic moments of compounds of the type R_6Mn_{23}, where R is a rare earth ion. Determination of the saturation moments on Mn with nine of the rare earths (Sm, Nd, Gd, Tb, Dy, Ho, Er, Tm, and Lu) showed that with one exception the rare earth and manganese moments are antiparallel; only in the gadolinium manganese compound was there complete ferromagnetic coupling. From the moment of Lu_6Mn_{23} the moment of 0.4μ_B per manganese atom was derived. The measured moments of the other compounds agreed closely with those calculated assuming a moment of 0.4 for Mn and the normal moment of gJ for the appropriate rare earth atom. (auth)

23110 CYCLIC STRAIN AND FATIGUE BEHAVIOR OF METALS IN THE CREEP RANGE. L. F. Coffin, Jr. (General Electric Research Lab., Schenectady, N. Y.). 24p. (CONF-446-84)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

The problem of the resistance of metals to low-cycle fatigue at elevated temperatures is considered. The approach followed was to develop a relationship between equivalent ductility, $\epsilon_{p'}$, and a parameter $P_1 = f(\epsilon_p, T)$ such that for particular strain rates and temperature the fatigue life can be determined from the well-known low-cycle fatigue equation $N_f^{\beta}\,\Delta\epsilon_p = \epsilon_{f'}/2$. Support for this approach was obtained from experiments on a 0.1%C, 2.0%Mo steel over a wide range of temperature and strain rates. It is proposed that construction of parametric curves for other steels in the creep range can be made from constant strain rate to fracture tensile tests. (auth)

23111 TERNARY CARBIDE PHASES FORMED BY SCANDIUM-GROUP ELEMENTS WITH ALUMINUM AND CARBON. S. Rosen and P. G. Sprang (Pratt and Whitney Aircraft, North Haven, Conn.). 26p. (CONF-715-8)

From 13th Annual Conference on Applications of X-Ray Analysis, Denver, Aug. 1964.

A group of ternary carbide phases formed by combination of an element of the scandium-group (which is taken to include the rare earth elements) with aluminum and carbon was found. These phases are related to the series of T_3BC_x compounds discovered by Stadelmaier. Atomic size effects showed that T_3BC_x phases behave in a manner similar to many ordered binary phases of AB_3 stoichiometry. There is a readjustment in size of the various metallic components, which results in effective radii compatible with cubic close packing. An anomaly that appears when the observed lattice parameters of T_3BC_x are related to the Goldschmidt Radii of the component atoms is discussed. Measurements of the intensities of x-ray diffraction peaks were used to show that the carbon atom in these phases occupies the octahedral hole in the center of a Cu_3Au-type unit cell. This position is maintained in systems, which contain varying amounts of carbon. (auth)

23112 BINARY INTERDIFFUSION IN BODY-CENTERED CUBIC TRANSITION METAL SYSTEMS. C. S. Hartley, J. E. Steedly, Jr., and L. D. Parsons (Air Force Materials Lab., Wright-Patterson AFB, Ohio). 44p. (CONF-691-7)

From Conference on Fusion of Body-Centered Cubic Materials, Gatlinburg, Tenn., Sept. 1964.

Diffusion studies made on Nb–V, Nb–Mo, Nb–Ti, Mo–Ti, Mo–Zr, Nb–Zr, and Ta–Pt alloys are summarized. Infinite diffusion couples, which satisfy the boundary conditions of either the Matano solution or Wagner solution to Ficks' second law, were used. Intrinsic diffusion coefficients were calculated in several cases using Darkens' treatment of binary diffusion. In certain instances it was found that this analysis yielded negative values for the intrinsic diffusion coefficient of the slower moving component. This is attributed to the existence of a finite chemical potential gradient due to vacancies. Enhanced diffusion in regions of steep concentration gradients was also attributed to this gradient. Representative values of the apparent activation energies and frequency factors for interdiffusion are presented. (auth)

23113 PROPERTIES AND BEHAVIOR OF BERYLLIUM–ALUMINUM ALLOYS. R. W. Fenn, Jr., D. D. Crooks, W. C. Coons, and E. E. Underwood (Lockheed Missiles and Space Co., Sunnyvale, Calif.). 39p. (CONF-729-19)

From International Conference on Beryllium, Philadelphia, Oct. 1964.

A series of ductile beryllium-aluminum alloys containing 24 to 43% aluminum, which were developed primarily for aerospace use, were evaluated and characterized. Mechanical properties, physical properties, and shop and service characteristics are described for developmental sheet and extrusion alloys as are the mechanical properties of two types of commercially produced Be-38% Al sheet. A structural efficiency comparison between Be–Al and competitive materials is given. Developmental extrusion alloys showed Young's modulus values varying from 29×10^6 psi to 37×10^6 psi as a function of aluminum content, while the heat-treated alloys exhibited elastic moduli about 5×10^6 psi lower than the as-extruded values. Tensile strength values ranged from 69 to 88 ksi in the as-extruded condition, with the heat-treated values being about 23 ksi lower. The developmental sheet alloys had modulus values about 4×10^6 psi lower than the as-extruded alloys, while the longitudinal tensile strengths of sheet varied between 44 and 79 ksi depending upon temper and aluminum content. Structural efficiency comparisons

showed magnesium and aluminum alloys to be about twice as heavy and titanium about three times as heavy as an equivalent load-carrying Be–Al structure. The data also suggest that Be–Al alloys should be capable of achieving 75% of the weight savings possible with beryllium. (auth)

23114 THE MEASUREMENT OF DIFFUSION COEFFICIENTS BY INTERNAL FRICTION. R. Gibala and C. Wert (Univ. of Illinois, Urbana). 41p. (CONF-691-8)

From Conference on Fusion of Body-Centered Cubic Materials, Gatlinburg, Tenn., Sept. 1964.

The basic principles involved in describing diffusion using anelastic measurements are discussed. Motions of individual atoms, which produce relaxation in certain solids, are used to describe diffusion of interstitials in bcc metals and of oxygen in Ge and Si. Motions of pairs of interstitials and other higher-order clusters are considered; their discussion is extended to clusters of interstitials with substitutional impurities. Consideration is also given to substitutional impurity clusters (which can produce the Zener relaxation) and to dislocation arrangements. (auth)

23115 THE BEHAVIOR OF A REFRACTORY METAL WITH REGARD TO FISSION PRODUCT CONTAINMENT AT HIGH TEMPERATURES. P. K. Conn, H. C. Brassfield, J. D. Elkins, and R. E. Blevins (General Electric Co., Idaho Falls, Idaho). 13p. (CONF-654-73)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The data obtained from laboratory studies on diffusion of fission gases in tantalum indicated that if the gas is placed in solution in the metal, short range diffusion can occur. However, results from in-pile tests indicated that diffusion across a wall of 0.5-mm thickness does not occur to any significant extent. (auth)

23116 THE USE OF A STEEL ALLOYED WITH BORON FOR MATERIALS WHICH HAVE TO HAVE A HIGH NEUTRON ABSORPTION COEFFICIENT. Thomas Harold Middleham and Eric Winearls Colbeck (to Hadfields Ltd.). German Patent 1,178,220. Sept. 17, 1964. Priority date Dec. 5, 1955, Great Britain.

Steel composed of carbon up to 0.25%, boron between 2.0 and 4.75%, aluminum between 0.08 and 13.0%, silicon up to 0.70%, manganese up to 0.76%, phosphorus up to 0.04%, sulfur up to 0.04% and the rest of iron, in which the contents of boron and aluminum are calibrated, is used for control rods in nuclear reactors. (Gmelin Inst.)

Radiation Effects

See also CHEMISTRY — Radiation Chemistry.

Refer also to abstracts 22895, 23164, 24014, 24084, 24089, 24102, 24123, 24160, and 24162.

23117 (AD-606809(p.1-10)) THE NRL HIGH-LEVEL RADIATION LABORATORY. H. E. Watson and L. E. Steele (Naval Research Lab., Washington, D. C.).

Design of the laboratory, which provides a facility for the study of highly radioactive materials, is described. Sources of gamma radiation as great as 0.5 MC can be safely handled. (J.R.D.)

23118 (BMI-1718) PREPARATION AND IRRADIATION OF BERYLLIA-COATED FUEL PARTICLES. Wilbur J. Wilson, Melvin F. Browning, Virginia M. Secrest, and John M. Blocher, Jr. (Battelle Memorial Inst., Columbus, Ohio). Mar. 16, 1965. Contract W-7405-eng-92. 72p. Dep.; $2.00(cy), 2(mn) CFSTI.

High-purity beryllia coatings were applied to UO_2 particles in a heated fluidized bed by several chemical reactions. Hydrolysis of $BeCl_2$ was the most promising and most thoroughly investigated. Dense beryllia-coated particles survived out-of-pile evaluation but failed severely during irradiation at 100°C. Performance during irradiation at elevated temperatures was good, but cracking occurred on thermal cycling. Coating grain structure and porosity varied with preparation temperature. Dense coatings with large equiaxed grains were obtained at 1400 to 1500°C, while porous coatings with submicron grains were obtained at 600 to 1100°C. Radially oriented needle-shaped grains were produced at 1250°C. The c-axis of BeO grains in dense coatings tended to be oriented radially. Coating density and hardness were essentially equal to that of single-crystal BeO. Addition of Al_2O_3, MgO, SiO_2, or ZrO_2 failed to inhibit formation of large BeO grains during subsequent heat treatment. Carbon was found to have an inhibiting effect late in the program, but the potential of this addition was not evaluated. (auth)

23119 (BNWL-1) ON THE COMBINED EFFECTS OF TEMPERATURE AND IRRADIATION ON THE MECHANICAL PROPERTIES OF AUSTENITIC STAINLESS STEELS. J. E. Irvin, A. L. Bement, and R. G. Hoagland (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1965. Contract AT(45-1)-1830. 26p. Dep.; $2.00(cy), 1(mn) CFSTI.

The effects of neutron irradiation and temperature on the mechanical properties of AISI 348 and 304 stainless steels were determined using smooth and notched tensile specimens containing different amounts of cold work. Smooth tensile specimens were irradiated at about 50, 290, and 750°C. Room temperature and 300°C tests on specimens in both the annealed and 25% cold worked conditions showed a marked reduction in ductility with increasing exposure and increasing test temperature. Damage accumulation occurred more rapidly at the intermediate irradiation temperature. Notched tensile specimens of AISI 348 stainless steel in the annealed, 10, 20, and 40% cold worked conditions were irradiated at about 290°C and tested at room temperature. The mode of fracture was ductile in nature throughout the range of cold work and neutron exposures studied. The effects of cold work, temperature, and chemical composition on the metallurgical stability of these materials were examined using magnetic measurements and x-ray diffraction. The magnetic susceptibility of both materials containing up to 70% cold work was determined before irradiation. No measurable change was noted in the magnetic susceptibility of either the annealed or 25% cold worked materials that were irradiated to exposures of 1.5×10^{21} neutrons/cm^2. Also, no changes in structure were observed. (P.C.H.)

23120 (BNWL-5) POSTIRRADIATION EVALUATION OF ZIRCALOY-2 PRTR PRESSURE TUBES. PART III. M. C. Fraser (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1965. Contract AT(45-1)-1830. 16p. Dep.; $1.00(cy), 1(mn) CFSTI

Data are given that provide a technical basis for selection of PRTR Zircaloy-2 pressure tubes for discharge and examination under the PRTR surveillance program. Burst test hoop strength and elongation data show that tubes having fast neutron exposure of 10^{21} or less have high strength with ductility; furthermore, the curves indicate that increasing exposure by a factor of two will not substantially change these conditions. Crack propagation data for tubes having fast neutron exposure of 5×10^{20} nvt or less show that resistance to crack propagation is unaffected by the neutron exposure, and that the crack length necessary for propagation at PRTR operating pressures is about 10 in. Hydride concentration data indicate general levels of hydride concentration are low, but high hydride concentrations have been found at flaws. The worst combined effect of flaw plus hydride produced a strength reduction of 25%. The testing method used is described. (P.C.H.)

23121 (FZK-212) EFFECTS OF REACTOR RADIATION ON FIVE HIGH-TEMPERATURE SOLID-FILM LUBRICANTS. R. H. McDaniel (General Dynamics/Fort Worth, Tex.). Feb. 1965. Contract AF29(601)-6213. 126p. (WL-TR-64-158) CFSTI.

Nuclear reactor irradiation and laboratory testing were performed on five high-temperature solid-film lubricants (PbS + MoS_2 + B_2O_3; CaF_2 coating; MoS_2 + graphite + sodium silicate; Almasol SFD-810; and Dynalube). The specimens were exposed to an average gamma dose of 2.2×10^{11} ergs/g(C) and associated neutrons of 5.2×10^{16} n/cm^2 (E > 2.9

Mev). Several test temperatures were investigated for each lubricant. Weibull plots and a ranking method were employed for data analysis. Reactor radiation had no significant effect on the wear life of the PbS + MoS_2 + B_2O_3 or the CaF_2 lubricants. However, detectable decreases in wear life were noted at 80°F for dynalube and at 900°F for Almasol SFD-810. The wear life of MoS_2 + graphite + sodium silicate suffered a decrease at 80°F but improved at 600°F and 1200°F. (P.C.H.)

23122 (HW-81603(p.3.1-14)) IRRADIATION BEHAVIOR OF CERAMIC FUELS. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

A status report is presented on the approximate exposures of irradiation specimens of Pu compounds and cermets which are still in-reactor. A capsule designed to measure the electrical resistivity and the Seebeck coefficient of UO_2 during irradiation was irradiated. Neutron irradiation was found to significantly increase the microhardness of UO_2 to a maximum between 0.2 and 1×10^{19} fissions/cm^3. Hydrogen-sintered (Th,Pu)O_2 solid solution pellets in the composition range of interest for thermal reactor fuels (up to 5 wt% PuO_2) exhibit satisfactory irradiation performance to a burnup of 2.4×10^{20} fissions/cm^3. A comparison of structures formed during irradiation indicate that 20 to 30% higher power output in these specimens would produce approximately the same temperature conditions as in UO_2. Ten elements containing various types of thoria powder were irradiated and destructively examined; data are included. The feasibility of safely operating ceramic fuel elements with molten cores was further demonstrated by the successful irradiation of a UO_2 test element having a 0.254-cm-dia hole drilled along a diameter of one of the pellets to allow molten oxide to impinge on the cladding. Postirradiation examination of thin-wall stainless steel-clad test element revealed no unusual fuel changes and no corrosion on the internal surfaces of the cladding. (auth)

23123 (HW-81603(p.5.1-14)) JOINT FUEL DEVELOPMENT PROGRAMS. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Newly developed ultrasonic testing methods showed small internal cracks in the weld area of many EBWR fuel rods. The cracks were propagated by thermal cycling. A process in which the end cap is replaced, was developed for repairing the defective rods. Test-capsule test results indicate that the UO_2–PuO_2 EBWR fuel performs satisfactorily. Maximum exposures of the 10 in-reactor and 22 discharged specimens are 4.3×10^{20} fissions/cm^3 (16,000 Mwd/ton of fuel) and 3.1×10^{20} fissions/cm^3 (11,600 Mwd/ton of fuel), respectively. The EBWR tubing order was completed with the receipt of 55 replacement tubes from one vendor. An additional group of 250 tubes was received from another vendor as a backup supply. The fabrication of 150 UO_2–6.6 wt% PuO_2 fuel rods for irradiation in the Saxton Reactor was begun. Pneumatic Impaction of 4400 lb of enriched UO_2 for an offsite customer was completed. One-half of this material was impacted during an 8 day period. Average UO_2 density after impaction was greater than 10.80 g/cc (98.4% TD). Beryllium-clad UO_2 fuel elements were assembled for CEA, France. Pneumatically impacted UO_2 powder was vibrationally compacted into French-supplied Be tubing. Elements were closed by magnetic force resistance butt welding. Three hundred ninety UO_2–2% PuO_2 fuel rods were vibrationally compacted. (auth)

23124 (HW-83298(p.8.1-4)) IRRADIATION EFFECTS ON MATERIALS. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Results of creep-rate tests in progress on 304 stainless steel at 500°C under stresses of 20,000 and 30,000 psi are discussed. The textures of Zircaloy-2 tubes from N-Reactor were examined, and equations for radiation damage mechanisms were developed. Oxidation rates for Haynes alloy at 1120°C were determined, and oxidation studies of Mo and TZM alloy at 1000°C were conducted. Results of irradiation tests on Al–Fe–U alloys and Fe–Si–U systems are reported. (J.R.D.)

23125 (NP-14958) EXPERIMENTAL INVESTIGATION OF THERMAL ANNEALING OF NUCLEAR-REACTOR-INDUCED COLORATION IN FUSED SILICA. F. C. Douglas and R. M. Gagosz (United Aircraft Corp., East Hartford, Conn. Research Labs.). Mar. 1965. Contract NASW-768. 146p. (D-910082-7)

An experimental investigation was made to determine the spectral transmission characteristics of fused silica over a range of temperatures prior to nuclear irradiation and during thermal annealing of reactor-induced coloration following exposure to a dose of 6×10^{17} nvt fast neutrons per cm^2. Commercially supplied specimens of Corning 7940, Amersil Infrasil, and Thermal American Spectrosil brands of fused silica, which were selected because of their high purity but found to differ slightly in chemical composition, were used. The pre-irradiation studies were carried out at a series of fixed temperatures. The annealing studies were carried out using both ramp variations of temperature with time and step-wise variations of temperature with time for temperatures between 22 and 1000°C. Most of the annealing data were obtained at a wavelength of 0.21 microns, although some annealing data were obtained following step-wise changes in temperature at wavelengths between 0.15 and 4.0 microns. Spectral transmission measurements also were made at wavelengths between 0.15 and 4.0 microns for all samples before nuclear irradiation and after thermal annealing. The results of the tests indicate that nuclear-reactor-induced coloration is greater and more difficult to remove in the ultraviolet portion of the spectrum than in either the visible or the infrared portions of the spectrum. Induced coloration in the ultraviolet is annealed out at temperatures between 700 and 900°C, and the rate of annealing corresponds to activation energies of between 2.2 and 2.8 ev in a first-order kinetic annealing process with a frequency factor of 10^{10} sec^{-1}. The three brands of fused silica in order of their degree of induced coloration and the difficulty of annealing this induced coloration were: Amersil Infrasil, Corning 7940, and Thermal American Spectrosil. (auth)

23126 (PAN-546/XIV) AGGLOMERATION OF HELIUM. RECRYSTALLISATION AND AGEING IN IRRADIATED ALUMINIUM–LITHIUM ALLOYS. E. Kamienski and W. Malinowski (Polish Academy of Sciences, Warsaw Inst. of Nuclear Research). Aug. 1964. 14p. Dep.

Aluminium containing 0.1, 0.25, 0.69, 1.75, 2.5, and 2.7 wt % lithium was irradiated to 10^{18} n/cm^2. Agglomeration of helium at the grain boundaries of alpha alloys and their recrystallization was investigated. As is indicated by the measurements of microhardness, age hardening of alpha plus beta alloys occurs in the reactor. (auth)

23127 (R64MCD500) SURFACE EFFECTS OF RADIATION ON TRANSISTORS. J. G. Woodruff (Military Communications Dept., General Electric Co., Oklahoma City, Okla.). Feb. 26, 1964. 57p.

An accumulation of data is presented as a result of a literature survey. Effects of dose, dose rate, bias, environment, and surface protection on transistors, in addition to the phenomena of recovery and memory, are described. Surface effects become apparent at radiation doses of 10^3 to 10^6 Rads. Increases of I_{CBO} by several orders of magnitude were observed in some transistors when the devices were subjected to simultaneous reverse-bias and ionizing radiation. Germanium transistor gain was observed to change by a factor of 2 or less. Glass-coated devices did not exhibit memory as did most other transistors. Most of the surface effects can be described by the ion-induced inversion layer model. Some devices can be screened for sensitivity to radiation by means of a short-time, high-level dose with correlation to subsequent low-level exposure results. Indications are that different types of transistors respond quite differently to radiation; that the response is quite dependent upon processing; and that the response of individual transistors of the same type may be quite variable. (auth)

23128 (ANL-Trans-174) INVESTIGATIONS OF THE PLASTIC RANGE OF NEUTRON-IRRADIATED COPPER SINGLE CRYSTALS. III. THE CHARACTERISTICS OF GLIDE OBSTACLES, IN PARTICULAR THE ACTIVATION ENERGY. Ch. Schwink. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Phys. Status Solidi, 7: 481-96(1964). 21p. Dep.(mn); $2.60(fs), $0.83(mf) JCL.

A λ quantitative analysis is made of the yield region of neutron-irradiated Cu single crystals. A study of the different parameters, especially the density of radiation-induced defects, leads to the activation energy U_0. With Seeger's potential, U_0 is found to be 2.6 ev for unannealed crystals (2×10^{18} nvt) at room temperature. Annealing increases U_0 slowly to about 3 ev. For the higher annealed specimens, a formula is required, and is given and investigated in detail. The slope of the defect potential and the temperature dependence of the activation energy are discussed. (auth)

23129 NEUTRON AND GAMMA IRRADIATION DAMAGE IN HIGH-PURITY GERMANIUM AT 4.2°K AND ITS RECOVERY TO 80°K. M. L. Swanson and D. A. Channing (Atomic Energy of Canada Ltd., Chalk River, Ont.). Appl. Phys. Letters, 6: 143-4(Apr. 1, 1965).

The radiation damage produced in high-purity Ge at 4.2°K by fission neutrons was studied, together with its recovery to 80°K. The photoconductivity (σ) induced by white light or by ionizing radiation in the neutron beam was measured. It was found that 6^{-1} varied linearly with irradiation up to doses of 5×10^{12} fission neutrons/cm² and that the recovery to 80°K of the change in 6^{-1} was 35% for n-type Ge and 20% for p-type Ge. These results were independent of the degree and method of carrier excitation. (D.C.W.)

23130 THE THEORY OF SWELLING OF MATERIALS BY GASES. V. V. Slezov and V. B. Shikin (Inst. of Applied Physics, Kharkov). Euro Nucl., 2: 127-9(Mar. 1965).

In studies of the swelling of material by gases under irradiation it is usually assumed that the total quantity of gas involved in the swelling process is constant or decreases linearly with time. The importance of coalescence in determining the pore size distribution function under irradiation at fairly high temperatures is discussed. A range of temperatures in which vacancy swelling is predominant was examined. (auth)

23131 EFFECT OF IRRADIATION ON THE MECHANICAL PROPERTIES OF SINGLE ZN CRYSTALS IN THE PRESENCE OF SURFACE ACTIVE HOT METALS. O. A. Troitskii and I. G. Berzina (Inst. of Physics and Chemistry, Academy of Sciences, USSR). Fiz. Metal. i Metalloved., 18: 125-31(1964).

The combined effects of a surface-active medium such as Hg and irradiation on the mechanical properties of single crystals of Zn were investigated. Proton (cyclotron), neutron (nuclear reactor), and electron (accelerator) irradiation were tested. 250 to 300 mm long single crystals were grown on a 99.99% Zn rod. A 5 mu Hg layer was deposited on the surface of the specimens as a surface-active agent. Proton irradiation (4.5 Mev, flow -0.52×10^{11}, 25-27°C), was found to have an anisotropic effect on deformation. The anisotropy was reflected in the ease with which the crystal glides along the cleavage surfaces 0001 under longitudinal irradiation applied to these surfaces. Softening of specimens treated in the nuclear reactor for over 10 days at 70 to 75°C was 75 to 80%. Irradiation applied for less than 100 hr improved mechanical properties at room temperature. Proton irradiation also lowered mechanical properties when 3% Hg (by weight) was present. It was concluded that this effect is due to the intensified action of hot metal in the field of irradiation. (CFSTI)

23132 EFFECT OF IRRADIATION WITH NEUTRONS ON THE LATTICE PARAMETERS OF CERTAIN METALS. V. A. Il'ina, V. K. Kritskaya, and B. V. Sharov. Fiz. Metal. i Metalloved., 19: 301-3(Feb. 1965). (In Russian)

X-ray-diffraction analysis showed that neutron irradiation with a total dose of $1 \cdot 10^{20}$ n/cm² increases the lattice parameter a of iron, chromium, and aluminum by approximately 0.03% and of molybdenum, by 0.012%, but decreases that of copper by 0.075%. The increase of a in Fe, Cr, and Al is explained by the considerable quantity of interstitial atoms, and the decrease in Cu, by the excess of vacancies. (CFSTI)

23133 EFFECT OF IRRADIATION WITH NEUTRONS ON THE FERRITIC-PEARLITIC STRUCTURE OF IRON–CARBON ALLOYS. E. A. Markovskii, M. M. Krasnoshchekov, and N. M. Kochegura. Fiz. Metal. i Metalloved., 19: 306-8(Feb. 1965). (In Russian)

Specimens of carbon steel (0.49% C, 0.56% Mn, 0.27% Si) and malleable iron (3.13% C, 0.65% Mn, 3.33% Si) annealed to a ferrite-pearlite structure with respective ferrite contents of 50 and 10% were irradiated with neutron doses of 10^{16} to 10^{20} neutron/cm². The hardness, tensile strength, yield strength, and wear resistance of both metals first dropped, but then increased with increasing dosage. The effect of irradiation on the microhardness of pearlite in both materials was almost identical. The microhardness dropped at first and then increased. The microhardness of ferrite in steel rose continuously and that in iron dropped slightly with prolonged irradiation. Thus, the decrease in hardness is associated primarily with softening of pearlite and may be attributed to radioinduced weakening of the grain and phase boundaries. It appears that two processes take place under the effects of irradiation: a strengthening associated with the formation of defects and blocking of dislocations, and a softening caused by changes in the grain and phase boundaries. Prolonged radiation with numerous impacts of fast neutrons increased the number of lattice distortions and, as a result, strengthened the metal. With short exposures, only a few lattice defects were formed and, as a result, the softening process prevailed. (CFSTI)

23134 ON THE GENERATION OF CURRENT PULSES BY CdS SINGLE CRYSTALS. S. I. Shakhovtsova, I. D. Konozenko, and E. A. Muzalevskii. Fiz. Tverd, Tela, 7: 278-9(1965).

Samples of cadmium sulfide single crystals were found to generate current pulses if exposed briefly to monochromatic or white light or to gamma radiation. The phenomenon was observed at temperatures of 330–270°K (for some samples down to 77.3°K), and the range of frequencies generated was from 0.2 to 0.05 cycles per second. The voltages measured on the samples corresponded to certain intervals of the illumination intensity. A sufficiently strong complementary illumination caused the phenomenon to disappear. (CFSTI)

23135 THE STRUCTURE OF THE SPECTRUM OF RADIATIVE CAPTURE OF HOLES BY THE A-CENTER IN SILICON. A. V. Yukhnevich. Fiz. Tverd. Tela, 7: 322-3(1965).

The spectrum of recombination radiation of silicon irradiated by gamma-quanta from a ^{60}Co source was investigated. A fine structure containing two peaks at 0.967 and 0.952 ev was observed in silicon containing A-centers. The energy state of the line with a peak at 0.967 ev indicates that it appears as a result of radiative capture of a hole from the valence band by an electron localized at the silicon structure defect level $E_c - 0.17$ ev (A-center). The half width of the line is less than 2×10^{-3} ev. Comparison of the line width with the value of kT at 80°K leads to the assumption that the holes participating in the recombination are also localized on some excited level of the A-center. Assuming a phononless transition, the excited level of the hole is located 0.025 ev above the edge of the valence band. The radiation with a maximum at 0.952 ev occurs apparently during the recombination of a hole with an electron at the $E_c - 0.17$ ev level with a simultaneous emission of transverse acoustic phonon. The radiation spectra in n- and p-type specimens have, in general, identical structure. The dependence of radiation intensity of the 0.967 and 0.952 ev peaks on the temperature at a constant injection current through the p-n junction shows that the concentration carrier remains constant. It is pointed out that ra-

diation was observed in n-type specimens even when only 5×10^{10} cm^{-3} A-centers are present. Thus, in some cases, recombination radiation can be used as a sensitive method for determining small concentrations of this type of defect. (CFSTI)

23136 COMPTON CURRENT AND POLARIZATION IN GAMMA-IRRADIATED DIELECTRICS. Bernhard Gross (International Atomic Energy Agency, Vienna). J. Appl. Phys., 36: 1635-41(May 1965).

Attenuation of a directional flux of gamma radiation in a solid dielectric is accompanied by the production of Compton current and space-charges. Under proper conditions the space-charge field can be high enough to produce breakdown. A phenomenological theory of these effects is developed, which is based on Compton current theory and experimental results of breakdown-induced charge release in glass. It takes into account space-charge formation due to the trapping of high-energy Compton electrons and persistent internal polarization associated with the production of electron-hole pairs by low-energy secondary electrons. (auth)

23137 ANNEALING OF INFRARED DEFECT ABSORPTION BANDS IN 40-Mev ELECTRON-IRRADIATED SILICON. J. C. Corelli, G. Oehler, J. F. Becker, and K. J. Eisentraut (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 36: 1787-8(May 1965).

Infrared absorption bands were observed in silicon following irradiation with high-energy electrons (40-60 Mev). The samples were irradiated along the ⟨111⟩ direction with the sample temperature below 40°C. Infrared spectra were measured with sample temperatures of 295 and 85°K. Preliminary annealing studies are discussed. (C.E.S.)

23138 ANNEALS OF ELECTRIC RESISTIVITY PRODUCED IN COPPER BY QUENCHING AND BY IRRADIATION. II. STUDY OF COPPER IRRADIATED WITH ELECTRONS. COMPARISON WITH QUENCHED COPPER. Cl. Budin, P. Lucasson, and A. Lucasson (Universite de Paris, Orsay, France). J. Phys. (Paris), 26: 9-18(Jan. 1965). (In French)

Using the same specimen, irradiation with 1.5-Mev electrons at −175°C and quenching in a hydrogen atmosphere were alternately performed. After each quench or irradiation, isothermal or isochronal anneals were performed in order to compare the mobilities of the point defects produced in each case. Activation energy determinations are not conclusive. Isochronal anneals show that after irradiation the specimen anneals in stage III at lower temperature than after a quench. (auth)

23139 CHANGES IN SOME OPTICAL AND DIELECTRIC PROPERTIES OF ROCHELLE SALT CRYSTALS AFFECTED BY HARD RADIATION. N. A. Romanyuk and N. S. Pidzyraylo (Inst. of Crystallography, Academy of Sciences, USSR). Kristallografiya, 9: 870-5(1964).

The effects of ultraviolet and x radiation on the absorption spectra, the dependence of the initial dielectric constant on the temperature, and the shape of the hysteresis loop of Rochelle salt crystals were investigated in specimens cut from a single crystal. Dielectric and optical measurements were carried out on specimens of 0.5−1 mm and 0.3−10 mm thick, respectively. In the case of x irradiation, the investigation proved some already known rules of variation for the initial dielectric constant, the hysteresis loop, and some other features of Rochelle salt. In the case of ultraviolet irradiation, both the initial dielectric constant and the form of the hysteresis loop vary qualitatively in the same manner. A comparison of the changes caused by ultraviolet and x irradiation of the crystal showed that the displacement of the Curie point due to the same relative changes in ϵ_{max} is considerably smaller for ultraviolet radiation, not exceeding several tenths of a degree. An investigation of the variation in the specimen's properties with the time showed that the ϵ_{max} changes during some definite time interval after irradiation, first departing from the initial state, then approaching the initial state. An investigation of the absorption spectra showed that definite changes in the absorption spectrum due to x irradiation were observed only during a longer isothermal rest of crystals after irradiation. They resulted in a slow decrease of absorptions in the investigated spectral range during four months of rest, and the optical density decreased at most by 15% of the value reached immediately after irradiation of the specimen. Ultraviolet irradiation appeared to cause no substantial changes in the absorption spectra of Rochelle salt crystals, even when the changes in ϵ_{max} were considerable. (CFSTI)

23140 EFFECT OF NUCLEAR IRRADIATION ON THE STRUCTURE AND PHYSICO-CHEMICAL REACTIVITY OF METAL SURFACES. R. Neider. Metall-Reinig. Vorbehandl., 13: 199-202(Oct. 1964). (In German)

Changes in the surface structure of metals and nonmetals caused by irradiation and changes in chemical reactivity were studied. Oxidation of Cu foils at 150°C, reduction of NiO at 275°C, and oxidation of graphite at 300 to 400°C were studied. (Rev. Metal Lit., 22: (Feb. 1965))

23141 TENSILE CREEP DUCTILITY OF NEUTRON-IRRADIATED ALPHA−URANIUM. E. C. Sykes and G. W. Greenwood (Berkeley Nuclear Labs., Gloucestershire, Eng.). Nature, 206: 181-2(Apr. 10, 1965).

Tensile specimens 3.81 cm gauge-length and 0.2 cm^2 cross section were machined from a bar of reactor grade uranium that had been irradiated at about 400°C until 0.05% of all uranium atoms were fissioned after about a year in the reactor. Tests were made using an Instron machine adapted for remote operation, but strain rates below 10^{-2} hr^{-1} (the lowest rate possible using the normal straining system) were obtained by dead weight loading. Above 525°C and at strain rates $\sim 10^{-2}$ hr^{-1}, there was little evidence of any remaining irradiation hardening and the stress-strain curves were comparable with those of the non-irradiated material, but there was a dramatic drop in creep ductility. In contrast with the 30% elongation of non-irradiated uranium, the irradiated material fractured at 0.5% elongation in all tests where the stress was greater than ~350 kg cm^{-2}. Below this stress there was a marked restoration of ductility, although the elongation reached was still below that of the non-irradiated material. It is suggested that the salient features of the effect of stress on ductility may be interpreted in terms of the growth and linking up on bubbles of fission gas. (P.C.H.)

23142 AN ELECTRON MICROSCOPE STUDY OF RADIATION DAMAGE IN SINGLE CRYSTAL GRAPHITE. C. Baker and A. Kelly (Cambridge Univ.). Phil. Mag. (8), 11: 729-46(Apr. 1965).

Single crystals of graphite were irradiated with neutrons to doses of up to 7.6×10^{19} nvt (Ni) at temperatures up to 900°C and examined in the electron microscope. The damage is resolved on irradiation at temperatures of ~250°C, and consists essentially of interstitial dislocation loops. Only a few per cent of the original number of point defects are collected into these loops. The crystals were annealed after irradiation at temperatures up to 2200°C. The loops anneal out, and there is evidence for their growth at high temperatures. It is concluded that the annealing out of the loops involves atom motion along the c axis and that the activation energy for this is ~5.5 ev. (auth)

23143 THERMAL CONDUCTIVITY OF ELECTRON-IRRADIATED GERMANIUM. Frederick L. Vook (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 138: A1234-41 (May 17, 1965).

Measurements of the change in low-temperature thermal conductivity of high-purity single-crystal Ge were made upon 2-Mev electron irradiation and annealing. Strong scattering of phonons by small concentrations of radiation-induced defects is observed. The additive thermal resistivity increases as the 0.58 power of the time integrated flux Φ rather than the first power observed for GaAs. Irradiation to 3.4×10^{18} 2-Mev e/cm^2 below 50°K gave $1/K - 1/K_0 = 1.7 \times 10^{-11}\Phi^{0.58}$cm-deg/W at 20°K. For Φ between 10^{16} and 10^{19} 2-Mev e/cm^2, the magnitude of the increase in thermal resistivity of Ge is comparable to that observed for GaAs even though the lattice strain is much smaller. Strain and mass-difference scattering theories

cannot explain the Ge data as they can the GaAs data. The Keyes or Pyle phonon-electron scattering theories, however, can explain the Ge results. A small amount of annealing of the additive thermal resistivity was observed to begin at 35°K in the high-purity Ge studied. This is in agreement with the first annealing stage seen by electrical measurements in degenerate n-type Ge by MacKay and Klontz and in degenerate p-type Ge by Gobeli. Large recovery states are seen at 125 and 200°K. In the annealing-temperature interval between 140 and 200°K, the thermal conductivity is strongly dependent on electron trapping and can be significantly decreased by a short illumination which changes the charge states of the defects. This demonstrates the phonon-electron scattering nature of the thermal resistivity. Measurements of the temperature dependence of the thermal conductivity indicate that the defects anneal as point defects. The large precipitation of point defects seen in GaAs is not seen in Ge, and almost completely recovery of the radiation-induced defects occurs by 405°K. Minima are observed in the temperature dependence of the thermal conductivity, suggesting localized mode scattering. (auth)

23144 RADIATION DAMAGE IN PLATINUM. M. J. Attardo and J. M. Galligan (Columbia Univ., New York). Phys. Rev. Letters, 14: 641-2(Apr. 19, 1965).

Chemically pure platinum was irradiated at 75°C in a reactor to a total irradiation of 10^{17} nvt. An examination of the platinum wire in a field-ion microscope with the specimen coupled to a bath at 78°K showed evidence of interstitial and vacancy clusters. (L.B.S.)

23145 A MODEL OF "LATTICE" HARDENING IN IRRADIATED COPPER CRYSTALS WITH THE EXTERNAL CHARACTERISTICS OF "SOURCE" HARDENING. M. J. Makin and J. V. Sharp (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Status Solidi, 9: 109-18(1965). (AERE-R-4801)

A model is proposed to explain the formation of slip lines in irradiated copper crystals during the propagation of the Lüders front. In this model it is shown that, due to the sweeping up of the irradiation produced defect clusters by deformation, the critical stress to produce a slip line is that required to operate the source in producing the first dislocation loop in the environment of the defect clusters. As the slipped area expands a pile-up forms and the stress required to expand this pile-up falls. Since on this scale a normal tensile machine is soft (the load is constant) the pile-up rapidly increases in size and velocity and hence slip lines should form very quickly. This was verified by high-speed photography. The sweeping up of the damage by deformation was also verified experimentally. The model has important consequences for "source" and "lattice" hardening. It is shown that the lattice hardening of the dispersed defects produces all the characteristics of the deformation which have formerly been used as evidence of "source" hardening. (auth)

23146 DIFFUSION OF TRITIUM FROM NEUTRON-IRRADIATED LITHIUM FLUORIDE. H. Cohen and W. S. Diethorn (Pennsylvania State Univ., University Park). Phys. Status Solidi, 9: 251-4(1965).

The release of tritium from LiF is well described by volume diffusion kinetics below 500°C and an activation energy of 51 kcal/mole. The tritium is introduced into the LiF by the $^6Li(n,\alpha)^3H$ reaction. Tritium release from massive LiF is complex; important factors include temperature history, initial tritium concentration (neutron exposure) and trapping of tritium in the LiF structure. (auth)

23147 FOCUSING COLLISIONS BETWEEN DISPLACED ATOMS IN AN IRRADIATED METAL. D. Grecu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 669-85(1964).

The process of focusing collisions along a linear chain of atoms is studied. It is assumed that the interaction potential is an exponential one and the study is carried out in the hard-core approximation, the hard-core potential radius depending on the energy. The calculations aim at determining the solid angle, as a function of the initial energy, within which the intial particle must be confined in order that the focusing process may take place. (auth)

23148 IMPURITY PHOTOCONDUCTIVITY IN GERMANIUM DUE TO GAMMA-RAY IRRADIATION. A. B. Gerasimov, B. M. Konovalenko, I. D. Yaroshetskii, and A. A. Barkalaya (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (English Transl.), 6: 2527-8(Apr. 1965). Translated from Fiz. Tverd. Tela, 6: 3166-8(Oct. 1964).

The photoconductivity spectra of n- and p-type germanium samples irradiated with ^{60}Co gamma rays were measured at 85°K, and the temperature dependence of the Hall coefficients was obtained between 77°K and room temperature. It was concluded that the numerous levels in the middle part of the forbidden band are not due to any associations of the point defects with doping atoms. (D.C.W.)

23149 THE EXTRA PROBLEM OF NUCLEAR VEHICLES: RADIATION HEATING. T. R. Strayhorn (General Dynamics, Ft. Worth, Tex.). Space/Aeron., 39: 111-15(1963).

The radiation heating of three typical aerospace materials — polyethylene, aluminum, and iron — is reviewed, and the dependence on the distance from the reactor, reactor operating time, and reactor power is shown. (L.B.S.)

23150 ON THE INFLUENCE OF X RADIATION ON THE IONIC CONDUCTIVITY OF KBr. H. Roehrig and A. Scharmann (Universitat, Giessen, Ger.). Z. Physik, 184: 191-7 (1965). (In German)

The ionic conductivity of KBr crystals was investigated before, during and after x irradiation at constant temperatures. Depending on the treatment of the crystals, the conductivity increases or decreases as function of time. The results can be explained by the assumptions of SMOLUCHOWSKI concerning cation vacancies. (auth)

23151 RADIATION DAMAGE IN CRYSTALS. Lewis T. Chadderton. Methuen's Monographs on Physical Subjects. London, Methuen and Co., Ltd., 1965. 210p.

Radiation damage in single crystals is described. An introduction is provided to the concept of a defect in a single crystal, which embraces both point and extended defects and the formation of one from the other. Properties of defects and methods of observing them are briefly considered. The production of a Frenkel defect by displacement of an atom from a lattice site is discussed. An analytical description is given of a collision between an incoming particle and a lattice atom. Calculation of the number of displaced atoms that might be expected to be formed by a given and properly monitored external radiation is described. The analytical treatment was extended to the many-body nature of the damaging process. It is shown that the effect of most types of radiation on a crystal can be examined either in terms of the sudden and rapid delivery of heat, the thermal spike, or else through a cascade process. The fission spike is described as an amalgam of thermal spikes and displacement cascades. The influence of the ordered lattice structure on the complex processes occurring during a radiation damage event was examined. Some of the models proposed for the atomic interaction potential are compared. The life history of the incident particle is discussed. (M.C.G.)

23152 SPECIFIC HEAT OF IRRADIATED GRAPHITE AT LOW TEMPERATURES. Osamu Kimura (Japan Atomic Energy Research Inst., Tokyo) and Hideji Suzuki. Session VI, Paper 1 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

A model proposed by Iwata and Suzuki for radiation damage in graphite was examined. According to their model, the principal defects in irradiated graphite at room temperature are interstitial clusters of C_2 molecules and vacancies. The specific heat of irradiated graphite was found to be considerably larger than annealed or unirradiated graphite at 1.7 to 16°K. (M.C.G.)

23153 ELECTRONIC STATES OF LATTICE DEFECTS IN IRRADIATED GRAPHITE. Tadao Iwata (Japan Atomic

Energy Research Inst., Tokyo). Session VI, Paper 2 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

The electronic states of lattice defects in irradiated graphite were considered, assuming that their atomic states follow the perviously proposed model in which single interstitial atoms act as donors of electrons and single vacancies as acceptors. (M.C.G.)

23154 IRRADIATION EFFECTS IN GLASSY CARBON. T. Shimada (Tokai Electrode Mfg. Co., Tokyo) and T. Kikuchi. Session VI, Paper 3 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

The effects of neutron irradiation on some properties of glassy carbon were studied. Dimensional changes were not observed and very little change in c-spacing was observed for neutron doses of 5×10^{18}, 8.5×10^{18}, and 2×10^{19} nvt. Thermal resistivity and Young's modulus increased following irradiation. The changes in electrical resistivity in glassy carbons were small compared with those in reactor graphites. (M.C.G.)

23155 DEFECT POPULATIONS IN IRRADIATED GRAPHITE. W. N. Reynolds (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Session VI, Paper 4 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

The annealing spectrum method of analysis was found to provide a useful guide to the interpretation of property changes in graphite in terms of defect populations. The annealing spectra were studied by total c-axis growth of a single crystal, Young's modulus increase, thermal conductivity increase, and basal plane contraction. (M.C.G.)

23156 ELECTRON MICROSCOPY OF STRUCTURAL CHANGES IN IRRADIATED GRAPHITE. E. M. Woodruff (General Electric Co., Richland, Wash.). Session VI, Paper 5 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

Replicas taken from identical areas of graphite samples before and after exposure to 1.1×10^{21} nvt, E > 0.18 Mev, at 700°C were compared and the observed differences were associated with bulk radioinduced contraction. The opening of microcracks was observed. The regions in which these cracks opened were apparently the artifacts of a "healed" microcrack system composed of disordered carbon. Radioinduced densification or ordering in disordered carbon can explain the observed separations. (M.C.G.)

23157 MECHANISMS OF RADIATION DAMAGE IN REACTOR MATERIALS. J. A. Brinkman and H. Wiedersich (North American Aviation Science Center, Thousand Oaks, Calif.). 78p. (CONF-512-16)

From American Society for Testing and Materials 67th Annual Meeting, Chicago, June 1964.

The general theory of radiation damage in solids is outlined briefly. Those aspects of the damage, which are important in altering the mechanical properties of reactor structural metals and alloys, are considered in greater detail. Procedures by which estimates can be made of the numbers of displaced atoms and of their spatial distribution, as well as of the stability of various damage configurations, are described. Three basic processes occur under irradiation, which can influence the metallurgical state of a material. Transmutations, mainly due to neutron capture, can change alloy compositions. Displacement of atoms from their original sites tend to homogenize the distribution of components of alloys on a microscopic scale. Excess defects introduced by radiation accelerate diffusion and, consequently, diffusion-controlled processes. The latter two effects will oppose each other in a number of cases, and the resulting balance will be determined mainly by temperature and radiation flux. High-temperature creep, since it is diffusion controlled, is enhanced under irradiation. Spike effects may also cause creep. The mechanistic concepts presently believed responsible for occurrence of the described phenomena, the manner in which order of magnitude calculations can be performed for any specific situation are outlined. (auth)

23158 DOMAIN ORIENTATION IN Mo PERMALLOY AND 65 Ni–Fe BY ELECTRON IRRADIATION AT 100°C. R. S. Sery and D. I. Gordon (Naval Ordnance Lab., Silver Spring, Md.). 11p. (CONF-794-7)

From Magnetism Conference, Minneapolis, Nov. 1964.

A variety of effects were observed in flat-ring polycrystalline samples of 5-80 Mo Permalloy and 65 Ni–Fe irradiated by 2-Mev electrons at temperatures from 70 to 170°C. For the Mo Permalloy samples, application of a 0.22-Oe field during irradiation to 1.10×10^{17} e/cm^2 resulted in square hysteresis loops with B (remanence) as high as 6700 G but with little or no increase in H (coercive force). In zero applied field, H increased and B and μ (permeability) decreased in all cases, but loop shapes were either rectangular, constricted, tri-stable, or conventional. The tri-stable loops, which appeared after a run in which the beam was interrupted several times, resembled those theorized by Kaya for the case of a material having two dominant anisotropy axes. Irradiation of 65 Ni-Fe with a 1-Oe field and a dose of 7×10^{17} e/cm^2 resulted in increases of ~100% in B and μ and a 50% increase of H. The "directional order theory" for magnetic annealing (including the case of zero applied field) can be applied to the results. However, at any given temperature the vacancy concentration increase due to irradiation accelerates the ordering process through enhancement of the diffusion rate. Hence directional ordering can occur at relatively low temperatures in irradiated materials. The thresholds of damage (in zero field) for 5-80 Mo Permalloy and 65 Ni–Fe were $>0.17 \times 10^{17}$ and $>1.0 \times 10^{17}$ e/cm^2, respectively. Post-irradiation measurements indicated long-term stability of all of these effects. (auth)

METEOROLOGY

See also GEOLOGY AND MINERALOGY — Site Survey and Selection.

23159 ARTIFICIAL RADIOACTIVITY AND OZONE, TRACERS IN DYNAMIC METEOROLOGY. Arlette Vassy and Olga Tanaevsky (Faculte des Sciences, Paris). Pure Appl. Geophys., 59: 239-42(1964). (In French)

Measurements made at the same location on artificial radioactivity of the air and ozone concentration were compared. The results show that in both cases these products reach ground level by discrete periods of time and not continuously. This is in agreement with Lambert's assumption of injections from the lower stratosphere through the tropopause barrier when this barrier is temporarily opened according to Staley's computations. Other examples show how ozone and radioactivity data give complementary information in the field of movements of the atmosphere. (auth)

23160 RADON-222: A NATURAL RADIOACTIVE TRACER AVAILABLE FOR USE IN MICROMETEOROLOGICAL STUDIES. John E. Pearson and Gary E. Jones (Univ. of Illinois, Urbana). 23p. (CONF-789-2)

From American Meteorological Society National Conference on Micrometeorology, Salt Lake City, Oct. 1964.

The temporal, geophysical, and geographical parameters related to the emanation of ^{222}Rn at the earth-atmosphere interface were studied. These studies were made to provide information necessary for evaluating boundary conditions when investigating the vertical diffusion coefficient in the atmosphere using naturally occurring ^{222}Rn as a tracer material. A system for collecting ^{222}Rn emanating at the surface of the earth with a minimum of disturbance to the site was developed and is described. Sampling patterns were designed to permit statistical analysis of emanation data with respect to location, soil type, meteorological conditions, and other parameters. The variation of emanation of ^{222}Rn with these parameters is reported. Comparative measurements made in Northern Illinois as well as in regions of Colorado and New Mexico are presented. Estimated time: 15 minutes. (auth)

23161 PARTICLE SIZE DETERMINATION BY USE OF ELECTROSTATIC PRECIPITATION PATTERNS AND RADIOACTIVE TRACERS. Gonzalo Fernandez (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). 95p. (CONF-654-70).

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The validity limits of a previously derived theoretical model of an electrostatic precipitator air sampler were determined. The theoretical model was investigated by insertion of radioactive micron-size microspheres into a closed-loop wind tunnel, whose airstream flows into an electrostatic precipitator. The precipitation pattern on the collection plates was determined by the pattern of radioactivity. Ideally, the particles should be segregated by size. The results were compared to the theoretical predictions, which were calculated with a digital computer program. Fourteen runs were made with 7 ± 3 and 35 ± 5 μ particles using ^{46}Sc. The results indicated good reproducibility and fair overall correspondence between experimental and theoretical data at 750 cm/sec for the 7 ± 3 μ particle and 450 cm/sec for the 35 ± 5 μ particle. However, the experimental and theoretical results tended to diverge as the particle velocity was increased by 200 cm/sec or the applied voltage was decreased in steps of 5 and 2.5 kv. Conclusions were that the results are reproducible within experimental error; the physical phenomena in the precipitator can be described by mathematical models as suggested in the original theoretical study; mathematical models being used are probably imperfect; and investigation of the validity of the theoretical model should continue. (auth)

PHYSICS

General

23162 (ORNL-3575) AN ELLIPTIC INTEGRAL COMPUTER PACKAGE FOR MAGNETIC FIELDS, FORCES, AND MUTUAL INDUCTANCES OF AXISYMMETRIC SYSTEMS; AND A VERSATILE LINE-TRACING ROUTINE. M. W. Garrett (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 29p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

A set of high-precision routines for the IBM 7090 is described that performs efficiently calculations often required on axially symmetric magnetic systems. These routines compute the vector potential, field components, and the mixed gradient $\partial B_\rho/\partial z$ for current systems and for certain idealized distributions of magnetized matter; they compute the force and mutual inductance between coaxial units of a system; and they can trace the lines of force, lines of constant total B, B_z, etc., for such systems. The tracing routine with slight changes should be able to find loci of constant values for any single-valued function of two variables, when a program exists to evaluate the function. Coaxial units of any combination may be circular loops, thin solenoids, thick cylindrical coils, uniformly magnetized rings, cylindrical sheets, or thick-walled cylinders. The six types may be intermixed. The programs compute fields and trace lines accurately even within the windings, and calculate force and mutual inductance between coils in contact, as well as the self-inductance of ideal solenoids and of thick cylindrical coils. The programs for current systems were developed from a set of six equations in elliptic integrals, which suffice when correlations are fully exploited for all the relevant properties of loops and solenoids. Thick coils are analyzed with the solenoid rather than the loop as the elementary unit. Magnetic properties are then integrated in radial depth by Gaussian numerical quadrature of variable order. The method can deal with coils whose sections are not rectangular and whose current densities are a function of the cylindrical radius, though the existing codes do not yet cover such cases. The procedure is simpler and faster than methods that require a more extensive use of numerical integration. Errors are routinely less than one part per million, in extreme cases less than one part per thousand. The sequence of calculations is controlled by switch entries on the data cards so that a widely varying series of related or independent problems, which may require all the listed operations in any order, may be solved with a single set of data cards. (auth)

23163 (ORNL-3650(p.111-86)) PHYSICAL RESEARCH. (Oak Ridge National Lab., Tenn.).

Research and development are reported on physics and mathematics, accelerators, nuclear physics, inorganic and organic chemistry, metallurgy, thermonuclear reactions, and reactor and hot-cell operations. (J.R.D.)

23164 (SU-SEL-64-103) QUARTERLY RESEARCH REVIEW NO. 10, JULY 1–SEPTEMBER 30, 1964. (Stanford Univ., Calif. Stanford Electronics Labs.). Contract AT(04-3)-326. 218p. Dep.(mn); $6.00(cy), 4(mn) CFSTI.

Research and development at the laboratories for solid state electronics, electron devices, systems theory, and radioscience are summarized. Information is included on ion spectra, laser material, plasma behavior, microwaves, magnetic materials, electro-optics, electrons in solids, luminescence, semiconductors, information theory, network organization, circuits, computers, and communication theory. (J.R.D.)

23165 OPTICAL ANALOGY OF PULSE COMPRESSION. P. Tournois. Ann. Radioelec., 19: 267-80(Oct. 1964). (In French)

There is a complete analogy between pulse compression systems and optical combinations. Techniques applied to optical combinations can be used for pulse compression systems and conversely. This analogy is demonstrated in the special and simplest case of compression of a rectangular pulse linearly modulated in frequency to which the optical parabola corresponds. The mechanism of compression of a rectangular pulse linearly modulated in frequency by a wave propagated along a dispersive line (traveling phase system) is studied first. This mechanism is then associated with an "equivalent optical system" which is shown to be also applicable in the case of pulse compression by localized phase systems. Finally, Rayleigh's law is used to determine tolerances in pulse compression systems, in the same way as this rule is applied in optics to determine tolerances in optical combinations. (auth)

23166 THE INTRODUCTION OF INTEGRATED COMPUTERS INTO NUCLEAR PHYSICAL EXPERIMENTS. G. Krueger (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirtschaft, 10: 118-24(Mar. 1965). (In German).

Nuclear physical measurement techniques with the computer as part of measuring equipment are discussed. In addition to the conventional use of electronic computers as aids to the analysis of experimental results and for theoretical calculations they may also appear as components of the nuclear physical measuring equipment itself. The computer permits the automatic acquisition and simultaneous processing of measurement data. Particularly in measurement of several parameters in many channels the "on-line" computers were found to be more than a match for the data extraction equipment so far used: the multichannel analyzer with large central storage and the magnetic tape equipment whose advantages and disadvantages in the case of various requirements are discussed. The construction and functions of an acquisition system for measurement data controlled by a computer are described using the Karlsruhe MIDAS system as an example. Several independent neutron experiments are connected to MIDAS. The electronic structure of the digital system is independent of the individual experiments. Adaptation to the various measurement conditions and the distribution and control of the flow of data are accomplished through the stored program of the computer. (auth)

23167 SIMILARITY RULES FOR THE MAGNETOHYDRODYNAMIC FLOW WITH THE HALL EFFECT. Humio Naruse. Bull. Aeronaut. Res. Inst., Univ. Tokyo, 3: 1-6(Sept. 1963). (In Japanese)

In order to study qualitatively the character of flow with Hall effect, a case in which the generalized Ohm's law is valid instead of the usual Ohm's law and the flow is incompressible and steady is considered. It is assumed that the wall is uniform along the z direction, the magnetic Reynolds number R_m is very small and the electric conductivity of the wall is zero or very small. Similarity rules are obtained, assuming that the magnetic field H is (0, H_0 (const.), 0) in the undisturbed state and $\partial^2 H_y/\partial x^2$ is zero up to the order R_m everywhere in the flow or outside the boundary layer when it exists. Examples of the flows in the neighborhood of the stagnation point and about the flat plate are studied in detail. (auth)

23168 GENERALIZATION OF THE BOLTZMANN EQUATION FOR AN INHOMOGENEOUS SYSTEM. G. Nicolis (Universite Libre, Brussels). Bull. Classe Sci., Acad. Roy. Belg. (5), 50: 771-87(1964). (In French)

A generalization of the Boltzmann equation for a spatially inhomogeneous system is derived, resulting from a systematic linear approximation in the gradients following a method developed by Prigogine. As a result an explicit expression of the inhomogeneous collision operator is given in terms of the homogeneous operator only. Finally, an application to the case of a hard sphere gas is discussed. For this special case, the annulation of a class of contributions is demonstrated, and the Enskog equation is obtained. (auth)

23169 REMARKS ON THE INTERACTION TERMS BETWEEN COMPONENTS OF A NON-UNIFORM GASEOUS

MIXTURE. J. Lemaire (Institut d'Astrophysique, Cointe-Sclessin, Belg.). Bull. Soc. Roy. Sci. Liege, 33: 769-86 (1964). (In French)

Using CHAPMAN-ENSKOG's method, accurate expressions for the collision terms P_i and R_i appearing in the equations of motion and energy of each constituent (i) in a mixture of perfect gases are calculated. The vector P_i represents the specific force acting on the gas (i) due to elastic collisions (i,j). It depends on the gradients of concentrations, on the gradient of total pressure and on the external forces. It can also be expressed in terms of diffusion velocities u_i. Its expression exhibits not only the usual friction term frequently used in plasma physics, but also another one of the same magnitude. The latter is proportional to the temperature gradient of the mixture and is the only one which does not vanish when diffusion equilibrium is reached. (auth)

23170 FLOW OF AN IMPERFECTLY CONDUCTING FLUID WITH QUASI ALIGNED FIELD. Roger Thibault (Faculte des Sciences de Rouen, Mont-Saint-Aignan, Seine-Maritime). Compt. Rend., 260: 1081-4(Jan. 25, 1965).

In the determination of a flow around a thin profile for a movement with quasi aligned field, the method of perturbations causes the following indeterminations: in the supersonic case, the general solution depends on an arbitrary solution of the Ackeret equation and in the subsonic case on a harmonic function and an arbitrary solution of the Prandtl-Glauert equation. (tr-auth)

23171 EXPERIMENTAL STUDY OF FORCED OSCILLATIONS OF AN ELECTROCONDUCTOR LIQUID IN A RECTILINEAR TUBE OF CIRCULAR CROSS SECTION IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Etienne Craususe, Francois Dorlhac, Yves Poirier, and Charles Vives (Centre d'Enseignement Superieur Scientifique d'Avignon, Vaucluse, France). Compt. Rend., 260: 1337-9(Feb. 1, 1965). (In French)

An experimental study was made of the forced and sinusoidal oscillations in a rectilinear tube of circular cross section of a viscous and electroconductor liquid exposed to a uniform magnetic field normal to the flow. Curves show the variations of the maximal mean velocity and of the phase difference for various values of the fundamental parameters. (tr-auth)

23172 STUDY OF THE MAGNETOHYDRODYNAMIC FLOW OF A LIQUID METAL BETWEEN TWO COAXIAL CYLINDER CONDUCTORS. Jean Lucidarme and Christian Rioux (Universite de Paris, Orsay, France). Compt. Rend., 260: 1566-7(Feb. 8, 1965). (In French)

The device makes it possible to study the behavior of a fluid jet under high pressure constituted by a liquid metal conductor contained between two coaxial cylinders in the presence of a magnetic field parallel to the generators, the internal cylinder being moved by a high rotation velocity. The value of the friction is to be determined as a function of the variables of velocity, pressure, and magnetic field. (tr-auth)

23173 STUDY OF THE THERMAL BALANCE OF A SPACE-LIMITED EXTENDED ARC IN A TWO-COMPONENT GAS MEDIUM. D. G. Bykhovskii and M. G. Fridlyand (All-Union Scientific Research Inst. of Arc-Welding Equipment, USSR). High Temp. (USSR) (English Transl.), 2: 296-9(May-June 1964). Translated from Teplofiz. Vysokikh Temp., 2: 329-32(May-June 1964).

The determination of the thermal balance of a d-c argon-hydrogen arc by a calorimetric method based on the principle of phase transformation of the heat-dissipating medium is discussed. The dependence of the heat flow in the arc current, power, and voltage is derived. The difference between the heat flows in two-component and one-component arcs is discussed. (auth)

23174 THE POSSIBILITY OF ELECTRON ENERGY ANALYSIS IN A COMBINED ELECTRIC AND MAGNETIC FIELD. M. V. Kurepa and D. Dj. Tosic (Inst. of Nuclear Sciences, Belgrade). Intern. J. Electron. (1), 18: 125-32 (Feb. 1965).

The motion of electrons in a combined electric and magnetic field was investigated theoretically to find out whether this combined field can be used as an electron energy analyser for inelastic cross-section measurements. Different cases of the electron motion which arise for various magnitudes of the magnetic field are discussed. (auth)

23175 DETERMINATION OF THE SHAPE OF A PLANE-SYMMETRIC ELECTRON BEAM IN CROSSED ELECTRIC AND MAGNETIC FIELDS. K. C. Gupta (Punjab Engineering Coll., Chandigarh, India). Intern. J. Electron. (1), 18: 177-80(Feb. 1965).

Spreading of an electron beam due to space charge forces under conditions similar to those in the interaction space of a crossed field microwave device is investigated. The transverse velocity of electrons at the edge of the beam due to the space charge forces is calculated. A graphical method based on the Hamilton–Jacobi equation is described for the modifications of the beam boundary. (auth)

23176 ON TRANSFORMATION OF THE STRUCTURE OF A TURBULENT MERCURY FLOW BEHIND A SUDDEN EXPANSION BY A TRANSVERSE MAGNETIC FIELD. G. G. Branover, A. B. Tsinober, and E. V. Shcherbinin. Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR, 8: 114-15(Jan. 1965). (In Russian)

A study was carried out of the effect of a transverse magnetic field on the velocity distribution in the flow behind a sudden expansion. Velocity measurements were performed using a Pitot-Prandtl tube, and the dynamic-static pressure difference was determined with a differential micromanometer. Diagrams are shown of the velocities at various cross sections of the expanding stream, for various Hartman numbers, calculated according to the hydraulic radius of current behind the expansion, and for set Reynolds number. (M.J.T.)

23177 INVESTIGATION OF THE PRODUCTION OF AXIALLY-SYMMETRICAL MAGNETIC FIELDS OF SPECIFIED SHAPE. G. V. Badalyan (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk, 17: 141-8 (1964). (In Russian)

A continuation of earlier work dealing with the feasibility of obtaining constant axially-symmetrical magnetic fields in the internal cavity of a ferromagnet (Izv. AN ArmSSR, ser. fiz.-mat. nauk, v. 17: no. 5, 121(1964)) is presented. An attempt is made to check on the practical effectiveness and suitability of the method. Magnet samples were made for the production and investigation of three types of fields: homogeneous, bell-shaped with crest upward or downward, and a cosinusoidal field. The magnet comprised a steel tube with inside diameter 112 mm and wall thickness 10 mm. The length was 23 cm for the homogeneous and bell-shaped fields, and 40 cm for the cosinusoidal field. The tube was covered on the base side by steel discs 14 mm thick, with a central hole 20 mm in diameter for the admission of measuring devices or of an electron beam. A distributed solenoidal coil was wound separately on an insulated form in such a way that when placed inside the magnetic tube the winding was in contact with the iron. The windings for the three types of field are described. The coils were fed from a standard VS-111 rectifier, with current up to 1.5 amp maintained stable to within 1%. The magnetic measurements were made with a flat pickup coil inserted inside the tube and feeding a ballistic galvanometer. The measurements consisted of plotting the axial distribution of the axial component of the magnetic field and the radial distribution of the axial component in both the central section of each magnet and in the sections near the ends, and of checking on the influence of holes in the end discs, of the finite thickness of the distributed winding, and of other factors on the field distributions in the magnets. The results are in good agreement with the theoretical predictions, and it is concluded that in view of the ease with which such magnets can be prepared, they are of practical interest. (ATD)

23178 PRESSURE-DEPENDENT BREAKDOWN POTENTIALS IN PENNING MIXTURES. Lorne M. Chanin and G. D. Rork (Honeywell Research Center, Hopkins, Minn.). J. Appl. Phys., 36: 1515-22(May 1965).

Measurements were made of the primary and secondary

electron ionization coefficients in neon–hydrogen, helium–hydrogen, and neon–argon mixtures using the Townsend technique. In these experiments, measurements were conducted over a considerable range of pressures at the E/p_0 value corresponding to the maximum of the Penning effect and for the optimum concentrations. Examination of the prebreakdown current growth indicated at fixed E/p_0 a pressure-dependent breakdown potential. Measurements of the primary coefficient as a function of pressure showed no significant pressure variation. Measurements of the secondary ionization coefficient, however, indicated that γ decreased with increasing pressure consistent with the observed breakdown potential variation. (auth)

23179 p-TYPE SURFACE LAYERS IN ION-BOMBARDED SILICON. L. Amadel, R. Gereth, and H. J. Queisser (ITT Semiconductors, Shockley Labs., Palo Alto, Calif.). J. Appl. Phys., 36: 1537-42(May 1965).

Silicon is bombarded at 400 to 900°C in a glow discharge of hydrogen with phosphine or diborane admixtures. Below 700°C, bombardment of n-type silicon with an initial resistivity of 200 Ω-cm creates deep ($0.5 - 2.5\ \mu$) p-type surface layers regardless of gas composition. The concentration $N_A(x)$ of the acceptors in the p layers obeys a simple law: $N_A(x) = N_0 \exp(-x/L)$. N_0 is the surface concentration at $x = 0$ which increases from 3.5×10^{16} acceptors cm^{-3} to 4×10^{18} acceptors cm^{-3} for bombardment temperatures increasing from 500 to 650°C. The decay constant L is found to be $0.2\ \mu$. Annealing experiments rule out the hypothesis that the p layers are caused by fast-diffusing acceptor impurities, e.g. aluminum or boron. It is proposed that the p layers are formed by vacancies which act as acceptor-like defects. (auth)

23180 THE EVOLUTION OF TRANS-ALFVENIC SHOCKS IN GASES OF FINITE ELECTRICAL CONDUCTIVITY. L. Todd (Cambridge Univ., Eng.). J. Fluid Mech., 21: 193-209(Feb. 1965).

The stability of steady, plane, one-dimensional, trans-Alfvénic shocks to small normal disturbances (i.e. those in which the perturbed quantities are functions only of time and the distance from the plane of the shock wave) is discussed. It is confirmed in detail that all plane-polarized trans-Alfvénic shocks, except the 2-3 type, are unstable to disturbances in those components of the magnetic field and velocity which are transverse to the plane of polarization. It is also shown that the 1-4 trans-Alfvénic shock is unstable to magneto-acoustic waves and contact fronts. The behavior of the 2-3 trans-Alfvénic shocks and of switch-on and switch-off shocks is discussed. (L.B.S.)

23181 ION EMISSION FROM HEATED METAL SURFACES. David Lichtman (Honeywell Research Center, Hopkins, Minn.). J. Vacuum Sci. Technol., 2: 91-2(Mar.-Apr. 1965).

The thermionic emission of positive ions from heated metal targets at temperatures well below 1000°K was observed in an ultrahigh-vacuum, mass-spectrometer system. With a target of stainless steel (type 303), Li, Na, K, Rb, and Cs ions were detected, although no K was found in an analysis of the steel. With a target consisting of an Al film on a Mo substrate, Al, K, and Na ions were detected. Emission of alkali species was also observed with single-crystal Ni targets. (D.C.W.)

23182 IMAGE CONTRACTOR. Hisashi Matsuda, Hiromitsu Makabushi, and Koreichi Ogata (Osaka Univ.). Mass Spectry. (Tokyo), 11: No. 22, 16-24(June 1963).

An apparatus which contracts or enlarges the spot of ion beam without energy dispersion is proposed. When two electric fields of sector type with the same field characterizing constant are oppositely combined in tandem and the source slit is placed at the focal point of the first field, then the image is focused at the focal point of the second field. The energy dispersion at the image position is cancelled out in the first approximation if the deflecting angles of two fields are equal even if the mean radii of them are different. Only the image is contracted or enlarged by the ratio of the radius of the first field to that of the second field. The coefficients of the second order aberration of this apparatus are calculated in the case of cylindrical electric field and of spherical electric field. The total spread of the image due to the second order aberration may be reduced less than 1 micron at proper conditions in the case of cylindrical elastic field with the deflecting angle of 45° and the contracting ratio 5. (auth)

23183 VORTICES IN AN IMPERFECT BOSE GAS. II. SINGLE-PARTICLE EXCITATIONS. Alexander L. Fetter (Univ. of California, Berkeley). Phys. Rev., 138: A709-16(May 3, 1965).

The single-particle excitations of an imperfect Bose gas with a vortex in the condensate are studied using the Bogoliubov approximation. The problem is reduced to an eigenvalue equation, whose solution yields both the single-particle energies and the eigenfunction expansion of the single-particle Green's function. The spectrum of the eigenvalues contains a discrete portion (bound states) and a continuous portion (scattering states). The lowest eigenvalue corresponding to angular momentum $l = 0$ and $l = \pm 1$ is determined variationally. In the long-wavelength limit, the eigenvalue for $l = \pm 1$ agrees with the frequency of normal modes calculated by Kelvin and Pitaevskii. The density of noncondensed particles is expressed in terms of the single-particle Green's function and is shown to be finite at the center of the vortex. (auth)

23184 PHENOMENOLOGICAL THEORY OF LASER BEAM FLUCTUATIONS AND BEAM MIXING. L. Mandel (Univ. of Rochester, N. Y.). Phys. Rev., 138: B753(May 10, 1965).

A quantum theoretical analysis of laser beam fluctuations and of the light beat experiments with two lasers is presented. With the help of experimental results on photon counting fluctuations in a single-mode laser field, some correlation properties of the field are derived. It is shown that the correlation equations are satisfied by states of the field which are much more general than coherent states. The equations lead directly to the spectral density of the intensity operator in the light beat experiments, which can be obtained from photoelectric measurements. The resulting expression is practically identical to that found by Forrester for light having thermal statistical properties. The reasons for this are discussed by a comparison of the corresponding probability distributions of photon counts and of the classical wave amplitude. (auth)

23185 HELIUM AFTERGLOW AND THE DECAY OF THE ELECTRON ENERGY. J. C. Ingraham and Sanborn C. Brown (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 138: A1015-22(May 17, 1965).

The electron energy decay in the afterglow of a pulsed d-c discharge in helium was studied over a pressure range from 0.03 mm to 5 mm Hg. The energy decay is found to be influenced by cooling due to electron-atom elastic recoil and heating due either to electron-metastable superelastic collisions at low pressures or to the ionizing collision between two metastable atoms at high pressures. The analysis allows for the deviation of the electron velocity distribution from Maxwellian resulting from these heating effects. (auth)

23186 NUCLEAR SPIN-LATTICE RELAXATION IN LIQUIDS. [PART] II. P. K. Sharma and R. P. Gupta (Univ. of Allahabad, India). Phys. Rev., 138: A1045-6 (May 17, 1965).

The spin-lattice relaxation in liquids was investigated on the basis of a modified jump-diffusion model taking into account the continuous diffusion of the center of vibrations in a quasicrystalline vibrational state. An expression for the spin-lattice relaxation time T_1 is derived. The theory was applied to water, and the theoretical parameters needed in the calculation are estimated from experimental data on cold-neutron scattering. It is again found that T_1 is not very sensitive to the details of the atomic motions in a liquid. (auth)

23187 COLLECTIVE OSCILLATIONS IN A DENSE ELECTRON GAS CONTAINING A FIXED POINT CHARGE. Edward A. Sziklas (United Aircraft Corp. Research Labs.,

East Hartford, Conn.). Phys. Rev., 138: A1070-82(May 17, 1965).

The collective excitations of a dense electron gas containing a fixed point charge with neutralizing positive background are investigated. A dielectric formulation, evaluated in a self-consistent-field approximation, yields a single-particle Schrödinger equation describing the collective modes. This equation has solutions belonging to the continuous spectrum (free plasmons) and to the discrete spectrum (bound plasmons). A cross section is derived for scattering of free plasmons by the point charge. The bound plasmon, representing a density wave trapped at the impurity site, has no counterpart in the uniform gas; it exists only for negative impurity charge and has an excitation frequency lying in the range $\omega_p/\sqrt{2} \leq \omega < \omega_p$, where ω_p is the plasma frequency. The bound plasmon appears to be reasonably well-defined excitation with a lifetime $\sim 10^{-15}$ sec in metals. A simple hydrodynamical model provides further physical insight. The experimental detection of bound and free plasmons in metals and the relation between surface plasmons, experimentally observed in many metals, and the predicted bound plasmon are discussed. (auth)

23188 STATISTICAL MECHANICS OF AN ASSEMBLY OF QUASIPARTICLES. Tohru Morita and Tomoyasu Tanaka (Catholic Univ. of America, Washington, D. C.). Phys. Rev., 138: A1088-96(May 17, 1965).

Low-lying excitations in a liquid or a solid are considered to have a long lifetime and to obey the Bose or Fermi statistics. They will be called quasiparticles in general. The low-lying energy levels of the system are considered to be characterized by a set of occupation numbers of the quasiparticles. The expressions for the grand partition function and the distribution function (the average occupation number) of the quasiparticles have the same structure as that for the classical lattice gas, under a nonuniform external field and with two-, three-, ···, body interactions. Therefore the virial expansion formula for the classical lattice gas can be applied to the system of quasiparticles. The result is simplified by assuming that the energy correction due to the simultaneous excitations of two, three, ···, n quasi-particles are of $O(V^{-1})$, $O(V^{-2})$, ···, $O(V^{-n+1})$, respectively, where V is the volume of the system. The resulting expression for the distribution function of the quasiparticles is either a Fermi or a Bose distribution function with an effective energy. The expression for the entropy in terms of the distribution function is the same as that for an ideal gas. This shows that Landau's formula for the distrubution function of quasiparticles for a Fermi liquid is valid under conditions which are more general and more practical than those given by Landau. Finally the situation in the Husimi-Temperley model is discussed in comparison with that in the Ising model from the point of view of the formulation. (auth)

23189 THE DISTRIBUTION OF CHARGED PARTICLES NEAR A MOVING SPACECRAFT. U. Samir and A. P. Willmore (London Univ.). Planetary Space Sci., 13: 285-96(Apr. 1965).

Electron and ion temperatures and densities obtained by Langmuir probes installed on the Ariel I satellite and a Black Knight rocket were used to study disturbances caused by a supersonic body moving through the ionosphere. A wake depleted of ions and electrons was observed. Evidence is given for the existence of a kind of turbulence in the wake in which strong rapid oscillations occur. A comparison is made with present theories and with similar measurements from the Explorer VIII satellite. (auth)

23190 DO NEGATIVE MATTER AND ENERGY EXIST IN PHYSICS? Vratislav Uysin. Pokroky Mat., Fys. Astron., 9: 29-40(1964). (In Czech)

A philosophical discussion is given on whether negative matter and energy, which are required by the principles of Dirac and by the solution of the Schroedinger relativistic wave equation, really exist. A summary of the solution of the Schroedinger relativistic wave equation is given to show the need for postulating negative matter and energy. The difficulties of detecting particles in negative energy states and the relation of negative energy to entropy are discussed. (TTT)

23191 PRODUCTION OF POWERFUL RADIOPULSES BY MEANS OF ELECTRIC EXPLOSION IN METALLIC WIRES. V. M. Kul'gavchuk. Pribory i Tekhn. Eksperim., No. 1, 132-7(Jan.-Feb. 1965). (In Russian)

Shock excitation of parallel oscillating circuits, joined in series with an exploding current of high density, was investigated. Copper and silver wires with a diameter of 0.04 to 0.1 mm and a length of 1.5 to 2.5 cm are used as commutating elements. It was shown that at discharge voltages of 4.5 to 7 kv and storage capacity of the condensers from 0.58 to 0.77 μf during the production of a current break in the discharge circuit, oscillations with little attenuation (logarithmic decrement of attenuation $(3 \text{ to } 6) \times 10^{-2}$) and with current at 100 and 1000 amp were excited in the range from 2.6 to 29 MHz. The dependence of the original excitation amplitudes on the number and diameter of wires in the commutator, the discharge voltage, and the natural frequency of the circuit was obtained. From this it was seen that the initial amplitude increases with the decreased diameter of the wires and decreases with the increase of frequency nearly to $1/\omega^2$. A method is proposed for the evaluation of the initial oscillation amplitudes. (tr-auth)

23192 CLASSICAL STATISTICAL MECHANICS AND THE ONE-DIMENSIONAL OSCILLATOR. J. L. Synge (Dublin Inst. for Advanced Studies). Proc. Roy. Irish Acad., Sect. A, 64: 1-15(Oct. 1964).

It is pointed out that classical statistical mechanics is a field theory with Liouville's equation as its field equation. The statistical mixing of a one-dimensional oscillator is examined, and the problem of an ensemble of magnetic compasses is discussed. (auth)

23193 NON-ADIABATIC MOTION OF CHARGED PARTICLES TRAVERSING A WEAK MAGNETIC FIELD: PITCH ANGLE SCATTERING. Sydney Chapman (Geophysical Inst., College, Alaska; High Altitude Observatory, Boulder, Colo.; and Univ. of Michigan, Ann Arbor) and Peter C. Kendall. Pure Appl. Geophys., 59: 100-22(1964).

A charged particle moves with velocity v in a constant non-uniform magnetic field H, spiralling with Larmor radius R. If R is small compared with the scale length L of the field, the magnetic moment associated with the Larmor motion of the particle is nearly constant. Consequently θ, the ("pitch") angle between v and H, varies as arcs in $H^{\frac{1}{2}}$. Hence θ in such adiabatic motion is approximately the same at points on the path where H has the same value. But the magnetic moment and the pitch angle may differ materially at two such points, each in the region where R/L is small, if between them the particle traverses a region where R/L is not small. This region of non-adiabatic motion "scatters" the pitch angles. Such scattering is investigated for regions of weak field (R large), with and without the presence of a neutral line along which H = 0. Either type of region, it is found, can scatter the pitch angles. This gives support to the theory proposed by Akasofu and Chapman to explain why auroral arcs and bands are very thin. The scattering examined is of interest also in connection with magnetic mirror devices for nuclear energy transformation. It may also have applications to phenomena of solar and stellar atmospheres. (auth)

23194 ON HIGH SPEED ELECTRONS IN DIRECT CURRENT DISCHARGE IN GASES. Radu Parvan (Univ. of Bucharest). Rev. Roumaine Phys., 9: 687-703(1964). (In French)

The problem of high-speed accelerated electrons in the negative column of a current discharge contained in Ar, H, and O was treated. The phenomena produced by these electrons were studied in the presence and absense of a magnetic field. The experimental results permitted a quantitative verification of the law of Stark and Aston. The experiments also treated the ratio between the numbers of

fast and slow electrons contributing to the maintenance of the discharge. (tr-auth)

23195 METHOD FOR MEASURING ENERGY TRANSFER FROM A MOLECULAR BEAM. D. McKeown and M. G. Fox (General Dynamics/Astronautics, San Diego, Calif.). Rev. Sci. Instr., 36: 656-9(May 1965).

A method was developed for measuring the transfer of energy from a molecular beam to a surface. The method makes use of temperature-sensitive Y-cut quartz crystals. A crystal was placed in the beam, and the energy transferred to its plating was determined by changes in its oscillating frequency. Crystals having a fundamental frequency of 10 Mc were used, and an energy transfer rate of 50 μw could be detected. Results are given for the transfer of energy by Ar^+ to an Au surface between 100 and 500 ev. (auth)

23196 MULTIPHOTON PROCESSES. A. M. Bonch-Bruevich and V. A. Khodovoi. Usp. Fiz. Nauk, 85: 3-64 (Jan. 1965). (In Russian)

A review of multiphoton processes is presented in three sections. The first section is devoted to the basic theory of multiphoton processes and to a general review of experiments performed in this field. The second section deals with multiphoton processes not requiring consideration of the interference effects. An analysis is presented of multiphoton transitions between Zeeman sublevels of sodium occurring in a rotating field and in a field applied in any arbitrary direction. An analysis is made of two-photon absorption in CaF_2 doped with Eu^{2+}, cesium vapor, liquids in which Raman scattering can be generated, and in KI crystals. Two-photon excitation of fluorescence in anthracine is also discussed. The third section is a review of multiphoton processes requiring consideration of interference effects. This section is divided into two parts. Part one is an analysis of processes associated with interference effects in each atom of an ensemble (level crossing and parametric resonance). Part two deals with multiphoton processes associated with interference effects in an ensemble on noninteracting systems. This last subdivision deals with harmonic generation in the SHF frequency range, second harmonic generation in the optical range, and certain effects in Raman scattering of laser radiation. 145 references. (CFSTI)

23197 SOME CONSEQUENCES OF EINSTEIN'S THEORY OF GRAVITATION WHEN APPLIED TO THE COSMOGONY OF SOLAR SYSTEM. M. Abdildin. Vestn. Leningr. Univ., No. 22, Ser. Fiz. i Khim., No. 4, 19-25 (1964). (In Russian)

Relativistic equations of translational and rotational motions are considered in the two body problem. Some results concerning the orientation, form, and stability of orbits are obtained. It is found that the orbit of body m_1 is stable, if the orbit is circular and lies in the equatorial plane of the rotation of body m_2. Secular effects of eccentricity variation and inclination of orbits derived. Possible applications to problems of planetary cosmogony are shown. (auth)

23198 THE ROTATION OF A CONDUCTING LIQUID IN A UNIFORM TRANSVERSE MAGNETIC FIELD. P. Smith (University, Keele, Staffordshire, Eng.). Z. Angew. Math. Mech., 44: 495-502(Oct.-Nov. 1964).

The effect of a uniform transverse magnetic field on an incompressible conducting liquid contained in a circular cylinder rotating with constant angular velocity is investigated. The problem is treated as a perturbation one for small magnetic Reynolds and Hartmann numbers. The first order approximation shows that the core of the liquid is slowed down to the second order while perturbations appear in the circular streamlines. However, the latter effects are extremely small for the cases considered. Some results are presented for a cylinder containing mercury. (auth)

23199 EXPERIMENTAL INVESTIGATIONS OF CHERENKOV RADIATION IN OPTICALLY UNIAXIAL CRYSTALS. Dieter Gfoeller (Universitat, Gottingen, Ger.). Z. Physik, 183: 83-9(1965). (In German)

The relative yields of Čerenkov radiation produced by beta particles of ^{32}P by passing through a thin uniaxial crystal plate were investigated experimentally with the aid of a fast coincidence and a linear gate circuit. Measurements were performed with electrons moving parallel to the optic axis of the uniaxial crystal plate and perpendicular to the optic axis. The experiment showed that the yield of Čerenkov radiation when the electrons moved parallel to the optic axis of the crystal was about 15% higher than in the case of the electrons moving perpendicular to it. This is in good accordance with theory. (auth)

23200 AN EXPERIMENTAL HYDROMAGNETIC INVESTIGATION OF JET-DRIVEN, CONFINED VORTEX-TYPE FLOW. J. J. Keyes, Jr. (Oak Ridge National Lab., Tenn.). p.277-96 of "Developments in Theoretical and Applied Mechanics. Vol. II." New York, Pergamon Press, 1965.

Experiments are described, which demonstrate the stabilizing influence of a strong axial magnetic field on the tangential flow of an electrolytic conductor generated by impingement of two-dimensional wall jets on the concave interior surface of a 1.1-in. dia tube. With no applied magnetic field, this flow situation is characterized by an apparent oscillatory instability in the boundary layer on the concave surface, which is observed to occur at very low values of tangential Reynolds modulus and which appears to initiate general turbulence throughout the flow field, thereby seriously limiting the potentiality of vortex-type flow for certain advanced energy conversion applications of current interest. Use of a concentrated aqueous solution of ammonium chloride at temperatures up to 210°F as the working fluid and a 62-kilogauss magnetic field enabled attainment of Hartmann moduli (based on tube radius) of up to 41, sufficient to increase the peripheral tangential Reynolds modulus (based on tube radius) for transition to instability from approximately 370 with no field to approximately 1580 with the maximum field. Accordingly, the observed transition Reynolds modulus was found to correlate well with Hartmann modulus. As a consequence of the total effect of the magnetic field, the wall friction coefficient was significantly decreased and the fractional recovery of injection velocity as tangential velocity near the periphery was correspondingly increased. The field was also found to be effective in suppression of an instability in the boundary layer on the end wall opposite the discharge opening and in increasing the ratio of tangential-to-radial flow on the end wall. (auth)

23201 THERMAL PHYSICS. Philip M. Morse. New York, W. A. Benjamin, Inc., 1965. 465p. $10.50.

Concepts of thermodynamics, kinetic theory, and statistical mechanics are presented for seniors and first-year graduate students. The illustrative material includes discussions of properties of liquid He, superconductors, and paramagnetic materials. Thermodynamic state variables and equations, the first and second laws, entropy, simple systems, the thermodynamic potentials, changes of phase, and chemical reactions are discussed. Kinetic theory is treated, including probability and distribution functions, velocity distributions, distributions in phase space, transport phenomena, and fluctuations. Statistical mechanics is considered, with discussions of microcanonical and canonical ensembles, crystals and gases, Bose-Einstein and Fermi-Dirac statistics, and interparticle forces. (M.J.T.)

23202 PHYSIKERTAGUNG HAMBURG. HAUPTVORTRÄGE VON DER TAGUNG DES VERBANDES DEUTSCHER PHYSIKALISCHER GESELLSCHAFTEN 1963. (Physicists' Meeting Hamburg. Chief Lectures at the Meeting of the United German Physical Society, 1963). E. Brueche, ed. Mosbach/Baden, Ger., Physik Verlag, 1964. 160p. (CONF-630902)

The ten invited papers presented at the 1963 annual meeting of the German Physics Society are compiled. The topics discussed are heat conduction in non-metallic crystals, physics of the sun's atmosphere, new investigations in the region of low temperatures, the present state of the

theory of ferromagnetism, cyclotron and electron spin resonance in diamagnetic semiconductors, present state of nuclear reactors, the Stark effect in the research on light and matter, information processing, and experiments with high energy neutrinos. Separate abstracts were prepared for some of the papers. (J.S.R.)

For abstracts of individual papers see: 23321, 23474, 23590, and 24128.

23203 CLASSICAL CHARGED PARTICLES. FOUNDATIONS OF THEIR THEORY. F. Rohrlich. Addisson-Wesley Series in Advanced Physics. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1965. 315p.

The theory of a relativistic classical charged point particle is developed in detail, following a review of the foundations of classical mechanics and electricity and magnetism with emphasis on the relativistic aspects. The one-particle theory is generalized to a finite number of particles, and the relations of the classical theory to general relativity and quantum mechanics are treated. (D.C.W.)

23204 THE TEMPERATURE FIELD IN AN ARC WITH A TRANSPIRATION COOLED ANODE. C. J. Cremers (Georgia Inst. of Tech., Atlanta) and E. R. G. Eckert. New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-94, 35p, $1.00. (CONF-650108-8)

From AIAA 2nd Aerospace Sciences Meeting, New York.

The temperature field in a high intensity free burning arc with transpiration cooled anode was measured spectroscopically. The atmosphere surrounding the arc as well as the transpirant was argon. The arc temperatures, under a variety of conditions, were measured using standard spectrometric methods. Several methods were used initially to check the internal consistency of the data as well as the degree of departure from thermodynamic equilibrium in the highly luminous portion of the arc. A line reversal technique was used to determine the average temperature in the semiluminous region next to the anode. This measurement indicates that the gas temperature in this region is approximately that of the anode surface through which it is blown. For low blowing rates of the transpirant a new transition between operating modes was observed. This transition is explainable in the light of data presented. The results of local measurements at higher blowing rates indicated here along with those from probe measurements made by Sheer permit speculation on the character of the semi-luminous region in front of the anode. (auth)

23205 MULTIDIMENSIONAL FLUID DYNAMICS CALCULATIONS WITH HIGH SPEED COMPUTERS. C. W. Hirt (Los Alamos Scientific Lab., N. Mex.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-3, 8p, $1.00. (CONF-650108-18)

From AIAA 2nd Aerospace Sciences Meeting, New York.

A brief survey is presented of several time dependent numerical methods for multi-dimensional fluid problems in use at the Los Alamos Scientific Laboratory. Emphasis is placed on the variety of problems which can be treated, as well as on the limitations of the methods used to treat them. No details are given of the specific numerical procedures. Three examples are presented. The first, the interaction of a shock with a bubble, illustrates a type of mixed Eulerian and Lagrangian method of calculation. The second example, a shock moving down a bent channel, illustrates a pure Lagrangian calculation. The third example illustrates an incompressible fluid calculation based on a pure Eulerian method. In the second two examples comparisons are made with experimental data. (auth)

23206 THE OPAQUE LIMIT IN RADIATION GAS DYNAMICS. James Wallace (AVCO Corp., Wilmington, Mass.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-80, 19p, $1.00. (CONF-650108-11)

From AIAA 2nd Aerospace Sciences Meeting, New York.

A uniformly valid theory of radiant heat transfer in an opaque gas is presented. This approach is valid both at the walls and in the absorbing medium. The results differ from the previous opaque limit and are of sufficient generality to allow for the calculation of the transport of radiation whenever the characteristic temperature or the source of radiation is different from the temperature of the absorbing medium. These results are then used to calculate the radiant heat transfer and temperature distribution between two infinite parallel plates. (auth)

23207 COLLISIONLESS FLOW OF AN IONIZED GAS THROUGH A CHANNEL WITH AN IMPOSED MAGNETIC FIELD. Morris Perlmutter (Lewis Research Center, Cleveland). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-124, 27p, $1.00. (CONF-650108-1)

From AIAA 2nd Aerospace Sciences Meeting, New York.

The integral equation method using interchange factors was used to obtain the solution for the collisionless mass flow of an ionized gas through a channel with an imposed magnetic field parallel to the channel wall and perpendicular to the mass through flow direction. Interchange factors between surface elements when the molecule path lines are not straight but curved are calculated by an analytical method and a Monte Carlo procedure. The Monte Carlo procedure was simple to set up and use compared with the analytical method in cases other than the simplest configurations. The results indicate that, for large magnetic field strengths, the mass flux of like charged ions incident on one wall will be much greater than on the other wall, and the mass flow through the channel will be larger than for zero magnetic field. (auth)

Accelerators

Refer also to abstracts 23355, 23614, 23615, 23906, 23940, and 24182.

23208 (CEA-R-2748) ANALYSE SIMULTANEE EN TEMPS ET EN ENERGIE DU FAISCEAU D'UN ACCELERATEUR LINEAIRE D'ELECTRONS. (Simultaneous Analysis with Respect to Time and Energy of a Linear Electron Accelerator Beam). Paul Garganne (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Feb. 1965. 17p. Dep.(mn).

A system is described for displaying on an oscilloscope screen the energy spectrum of the electrons located in time at a particular moment of the total electron pulse accelerated by a linac. The shaping transistor circuitry is described. Some examples are given concerning the experimental results observed with such a system at the Saclay Linac. (auth)

23209 (RPI-328-20) LINEAR ACCELERATOR PROJECT. Progress Report, October — December 1964. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 70p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Information concerning experimental work carried out during the report period is presented under 15 topics. Separate abstracts were prepared for eight. Topics for which no abstracts were prepared were concerned with on-line data acquisition, neutron spectra in D_2O, ^{233}U fission spark chambers, electron irradiaton of Ge and Si, isomer ratios in the reactions $^{45}Sc(\gamma,n)^{44}Sc$ and $^{46}Ti(\lambda,np)^{44}Sc$ relative yields for $(\gamma,2n)$, (γ,α), $(\gamma,2p)$, and $(\gamma,3n)$ reactions in ^{51}V, and photonuclear reactions in ^{45}Sc. (J.R.D.)

For abstracts of individual sections see: 23596, 23597, 23598, 23599, 23600, 23630, 23631, and 24031.

23210 (UCRL-11792) ACCELERATOR ALIGNMENT — A PROBLEM IN FEEDBACK-CONTROL SYSTEMS. Birchard L. Kortegaard (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 25, 1965. Contract W-7405-eng-48. 9p. (CONF-650306-41). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

Obtaining and keeping a satisfactory closed beam orbit

is a major problem in the design of large accelerators. The system determining this orbit has many variables, these variables are distributed around the accelerator structure, and the existence of the beam is periodic. There are techniques whereby an equilibrium orbit may first be obtained and thereafter maintained in the presence of all expected disturbances, by means of an electro-mechanical control system employing beam-position monitors. These techniques further permit a wide variety of operator experiments, such as trying various orbits, or restricting the spatial harmonic content of magnet repositioning. Certain of these techniques are illustrated. The discussion is restricted to an elementary magnet-position control system for maintaining a closed orbit in the presence of magnet support settling. We assume the beam to be continuously present, rather than to be discrete with time. This and other errors, such as magnet imperfections, and other control variables, such as backleg windings, would be handled in the same general way in a realistic design. The aim is to show a technique whereby these interacting, multivariable control systems may be designed and the minimum expected performance bounded. (auth)

23211 (UCRL-11803) STABILIZATION OF ACCELERATING VOLTAGE UNDER HIGH-INTENSITY BEAM LOADING. Q. A. Kerns and W. S. Flood (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 1965. Contract W-7405-eng-48. 16p. (CONF-650306-44). Dep. (mn); $1.00(cy), 1(mn) CFSTI.

From Particle Accelerating Conference, Washington, D. C.

The problem of fluctuating beam load in high-intensity cascade synchrotrons is discussed. A comparison is made of various methods of controlling r-f system amplitude and phase fluctuations, with emphasis on feedback control as an economical method of stabilization. Equations describing performance are given, together with typical values for the 200 Bev machine at 3×10^{13} protons/pulse. (auth)

23212 DETERMINATION OF THE SHAPE OF THE MAGNETIC FIELD OF AN ISOCHRONOUS CYCLOTRON BY THE HODOSCOPE METHOD. J. Aucouturier. Ann. Radioelec., 19: 281-99(Oct. 1964). (In French)

The magnetic field and particle trajectories in an isochronous cyclotron were investigated, using Hall probes and the fact that a current-carrying wire in a magnetic field takes the position of a particle trajectory. The theoretical bases of the measurements are outlined, and the results are presented. (D.C.W.)

23213 ELECTRO-OPTICAL TREATMENT OF ASYMMETRIZED FIELD QUADRUPOLE LENSES. Ede Koltay and Gyula Szabo. At. Kozlemen., 6: 105-29(Dec. 1964). (In Hungarian)

Quadrupole lenses and lens systems are often employed elements of ion transport systems. Due to their astigmatic focusing property, they are highly suitable for transferring the beam of cylindrical symmetry into the analyzing magnet with narrow slits. The position and direction instabilities appearing in the ion-beam obtained from the accelerator require setting up an optical system between the accelerating and analyzing magnets, which compensating the changes can guarantee the constancy of the position and direction of the beam at the entrance of the analyzing magnet. The electron optical description of an ion-transport system of this kind, formed by an asymmetrized field quadrupole-pair, is given. In case of asymmetrical feeding of the poles of the usual symmetrical quadrupole lenses, the resulting field, according to measurements in an electrolytic trough, suffers simple displacement of the center—without changing its structure. Taking this as a starting point, the electron-optical treatment of the asymmetrical quadrupole lenses and lens-pairs can be achieved by the simple extension of the usual matrix method. The results of the calculations carried out by this method were checked by deflecting experiments, and it was demonstrated that the results of the experiments agree within error with the calculated data. The calculations demonstrate that the asymmetrization does not influence the cardinal distances, thus the asymmetry used for the correction of position does not change the axial position of the image, but it permits a shift to an optional place in the image plane, or the image can be held in an axial point, with an optional entrance direction and axial distance. (auth)

23214 CURRENT INTEGRATOR FOR MEASURING THE ION CURRENT OF ACCELERATORS. Balint Schlenk and Laszlo Mesko. At. Kozlemen., 6: 151-6(Dec. 1964). (In Hungarian)

The description is given of a current integrator for measuring the ion current of accelerators, and the measuring data concerning range, calibration, accuracy, and stability of calibration, are presented. (L.B.S.)

23215 CYCLOTRON FOR ISOTOPE PRODUCTION. Atomics, [18:] 30-1(Mar.-Apr. 1965).

A cyclotron that is to be designed and operated for isotope production is discussed. The cyclotron is of the azimuthally variable field type and will accelerate protons to 25 Mev, deuterons to 15 Mev, and alpha particles to 30 Mev. The advantages of cyclotron-produced otopes are discussed. (C.E.S.)

23216 THE EXPERIMENTAL PROGRAM AT DESY. B. Elsner (Deutsches Elektronen-Synchrotron, Hamburg). Atompraxis, 11: 73-9(Feb. 1965). (In German)

It is possible at the "Deutsches Elektronen-Synchrotron" DESY to investigate reactions with electrons and photons at energies up to 6 (later 7.5) Bev. The electromagnetic structure of the nucleons can be measured by electron-nucleon scattering. The quantum numbers of the elementary particles and resonances produced and the strength of the coupling between strong and electromagnetic interactions can be measured by photoproduction of mesons and resonances. A typical experimental set-up is shown, the methods and instruments typically used in high-energy physics are described. All experiments planned and performed at DESY are described. (auth)

23217 THE ANALYSING AND BEAM TRANSPORT EQUIPMENT FOR THE 1.5 Mev ACCELERATOR. B. A. Anicin, A. Koicki, and B. S. Marsicanin. Bull. Boris Kidrich Inst. Nucl. Sci., 15: 247-61(Oct. 1964).

An electrostatic analyzer and a beam-transport quadrupole channel used in nuclear reaction experiments on a 1.5-Mev Cockcroft-Walton accelerator are described. The analyzer is designed as an absolute instrument. The choice of parameters to meet the specific requirements is discussed. The voltage scale is based on mechanical and electrical measurements, which are described in some detail. To avoid high radiation background the beam is transported 7.3 m from the exit slit of the analyzer by two pairs of quadrupole lenses. The design of the channel is discussed. To test the accuracy of the voltage scale based on the constant of the analyzer, the energy of Al(p,γ) and F(p,αγ) resonances was measured. Good agreement with previous results was obtained. (auth)

23218 ON PARTICLE SEPARATORS. Y. Hisatoshi. Genshikaku Kenkyu, 8: 21-32(1963). (In Japanese)

Methods for separating the secondary particles produced in the Bev level accelerators—static separator, rf separator, degrader method, and the method of separation by strong interaction are reviewed. (L.B.S.)

23219 A PNEUMATIC SUPPORT. Y. Kobayashi. Genshikaku Kenkyu, 8: 89-93(1963). (In Japanese)

A pneumatic support for moving the approximately 27-ton analyzer magnet for experiments in electron synchrotrons is described. This support consists of three supporting points formed by four discs each of which has an effective area of 2,000 cm^2 and is capable of supporting 8 tons (maximum pressure 4 kg/cm^2). The disc is surrounded by a synthetic-rubber ring of specific cross-section which prevents air leakage during pumping through the air inlet and the force to push up the heavy object is thus produced. Since most of the weight is being supported by air the object may be easily moved. The bed surface which is usually made up with a number of iron plates must be as smooth as possible. The joints are sealed with plastic or ethylene tapes. (NFSAIS)

23220 SOME RESULTS ON THE PRODUCTION OF A BEAM OF HIGH INTENSITY AND GOOD RESOLUTION. P. Bretonneau, M. Dumail, and P. Kerzreho (Universite de Paris, Orsay, France). J. Phys. (Paris), 26: 35A-6A (Jan. 1965). (In French)

A 4-Mev Van de Graaff accelerator was installed in the Joliot-Curie Laboratory of the Institut du Radium. A suitable optical system at the output of the device gives good resolution ($\Delta E/E \approx 5 \times 10^{-4}$) of the beam after analysis. (auth)

23221 STABILITY OF A CLUSTER IN A SYNCHROTRON WITH AUTOMATIC CONTROL. E. A. Zhil'kov. Pribory i Tekhn. Eksperim., No. 1, 17-20(Jan.-Feb. 1965). (In Russian)

The analysis of the stability of a cluster of finite size in a proton synchrotron is given together with the calculation of the frequency characteristics of automatic control systems for the radial and phase state of particles. (tr-auth)

23222 SHAPING OF A HIGH-ENERGY μ-MESON BEAM. N. A. Burgov and A. G. Beda (Inst. of Theoretical and Experimental Physics, Moscow). Pribory i Tekhn. Eksperim., No. 1, 20-4(Jan.-Feb. 1965). (In Russian)

The method of shaping high energy meson (μ) beams ($P \sim 1$ Bev/c) was investigated with the help of iron-free systems consisting of some parallel conductors, by which the current goes at high energy in one direction. It was shown that the systems delay, in the immediate proximity, a large part of the μ mesons formed by the decomposition of π mesons. The competence of the proposed method was confirmed by experiments on electron models. Thermal and dynamic analyses, confirming the possibility of the design of efficient installations, led to specially prepared isolated dodecametric sections for the proposed system. (tr-auth)

23223 SHAPING OF π-MESON BEAM FOR A METER PROPANE BUBBLE CHAMBER. V. S. Kladnitskii and V. B. Flyagin. Pribory i Tekhn. Eksperim., No. 1, 24-7 (Jan.-Feb. 1965). (In Russian)

The design of a magnetic channel that makes it possible to use the magnetic field of the synchrocyclotron for isolated meson (π^-) beams with momentum of 5 Bev/c and with a momentum spread of ±2% was described. (tr-auth)

23224 PREPARATION OF CARBON, NITROGEN, OXYGEN, NEON, AND ARGON IONS IN A PULSE SOURCE AND THEIR ACCELERATION IN CYCLOTRONS. A. S. Pasyuk and Ch'i Ch'ien (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 1, 28-33 (Jan.-Feb. 1965). (In Russian)

Some results obtained from work with the ion sources in the U-300 and U-150 cyclotrons of the Joint Institute for Nuclear Research were reported. In the 3-meter cyclotron U-300 mean currents of $^{40}Ar^{7+}$ of about 5 μamp and of $^{40}Ar^{8+}$ of 0.8 μamp in a radius of 100 cm were obtained. In the six-meter cyclotron U-150 mean currents of 1.2 μamp for $^{20}Ne^{6+}$ ions and 0.01 μamp for $^{20}Ne^{7+}$ in a 50-cm radius were obtained. (tr-auth)

23225 FAST BEAM EXTRACTION FROM A SYNCHROPHASOTRON TO A TARGET. L. P. Zinov'ev, I. B. Issinskii, V. I. Kotov, E. M. Kulakova, K. P. Myznikov, and N. I. Pavlov (Joint Inst. for Nuclear Research, Dubna, USSR). Pribory i Tekhn. Eksperim., No. 1, 33-8(Jan.-Feb. 1965). (In Russian)

Theoretical and experimental analyses of the movement of particles were conducted by parametric resonance in a weak-focusing synchrocyclotron. On the basis of this investigation a system was developed for application to the synchrocyclotron at 10 Bev for fast beam extraction to a target. Resonance conditions are created at the end of the acceleration by coils placed inside the vacuum chamber. The current in the coils is supplied by the discharge of a battery of condensers. Such a system makes it possible to shorten the time of collision of beam with target to 30 μsec. (tr-auth)

23226 THE 50-Mev BETATRON INSTALLATION AT VNIIM. N. D. Villeval'de, Yu. V. Lysanov, V. V. Skotnikov, K. K. Klebnikov, and M. F. Yudin (All-Union Research Inst. of Metrology, USSR). Pribory i Tekhn. Eksperim, No. 1, 38-43(Jan.-Feb. 1965). (In Russian)

The basic characteristics of the VNIIM betatron installation with maximum energy of the bremsstrahlung at 50 Mev were described. The efficiency of the absorbed dose of bremsstrahlung at 1-m distances from the target is ~90 rad/min. (tr-auth)

23227 OPERATION OF ELECTROSTATIC ACCELERATOR EG-2.5. V. A. Romanov, A. N. Serbinov, and N. I. Dudkin. Pribory i Tekhn. Eksperim., No. 1, 43-9(Jan.-Feb. 1965). (In Russian)

The operation of the electrostatic accelerator EG-2.5 and changes made in the construction of individual units of the accelerator to improve its operation were described. (tr-auth)

23228 ALIGNMENT OF γ BEAM IN CYCLIC ELECTRON ACCELERATORS. Z. L. Artem'eva and K. N. Shorin (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 1, 201-2(Jan.-Feb. 1965). (In Russian)

A method for the measurement of the alignment of the γ beam output from cyclic electron accelerators by means of the pulse effect on the orbit contour at the end of the acceleration was described. The method makes it possible to simplify the construction of targets and expands the possibility of the usual methods for the control of γ beams. The results of the experiments on synchrotrons with energies ~700 Mev were reported. (tr-auth)

23229 OBTAINING ACCELERATED POSITRON BEAMS ON A LINEAR ELECTRON ACCELERATOR. I. A. Grishaev, A. S. Litvinenko, V. I. Nikiforov, and A. N. Fisun. Ukr. Fiz. Zh., 10: 260-2(Jan. 1965). (In Ukrainian)

A description is given of the results of preliminary experiments on obtaining accelerated positron beams on a linear electron accelerator. The conversion factor of electrons into positrons is found to equal 2×10^{-6} positron/electron at maximum spectra, which gives 1.03×10^6 positrons per pulse over an energetic range of ±10%. (auth)

23230 ADIABATIC PARTICLE PATHS IN SPATIAL STRONGLY VARYING FIELDS. K. Schindler (Kernforschungsanlage, Julich, Ger.). Z. Physik, 183: 100-12 (1965). (In German)

The adiabatic invariance properties for charged particles moving in an electromagnetic field are studied for the case in which the field consists of a constant homogeneous magnetic field and a small scale oscillatory electromagnetic field varying slowly with time. The small scale part is one-dimensional and is present only during a finite (but reasonably long) time. It turns out that the adiabatic invariance of the magnetic moment as known for wavelengths larger than or of the order of the gyro-radius also applies for short wavelengths. The invariance becomes even better as the scale tends to zero. An invariance result previously obtained by Krall and Rosenbluth for a particular wave form with small amplitude follows by proper specialization. Some physical aspects of the results are discussed. (auth)

23231 TARGET APPARATUS FOR THE VAN DE GRAAFF ACCELERATOR /Q-1134/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). 48 drawings. (CAPE-1188)

The target apparatus described includes scattering chambers; a nuclear multiple plate camera; a multiple foil positioner; a leveling table, target holder; and a beam collimator for one of the scattering chambers. (For details, see TID-4100) (M.C.G.)

23232 THE APPLICATION OF SUPERCONDUCTIVITY TO ELECTRON LINEAR ACCELERATORS. H. A. Schwettman, P. B. Wilson, J. M. Pierce, and W. M. Fairbank (Stanford Univ., Calif.). 26p. (CONF-554-15)

From Cryogenic Engineering Conference, Philadelphia, Aug. 1964.

Improvements in operating characteristics of linear electron accelerators from superconducting accelerating structures are described. Representative calculations and some

experimental results are shown for energy gradients and duty cycles. (R.E.U.)

23233 LINEAR PARTICLE ACCELERATOR WITH A WAVEGUIDE OF GEOMETRICALLY PERIODIC STRUCTURE. Guy Azam and Hubert Leboutet (to CSF Compagnie Generale de Telegraphie). German Patent 1,178,155. Sept. 17, 1964. Priority date Mar. 24, 1961, [France].

The diameters of the holes of the irises undulate along the axis of the waveguide between a maximum value and a minimum value, which depend on the threshold of the propagation of the TM_{210} mode. (Gmelin Inst.)

23234 LINEAR ION ACCELERATOR. Hubert Leboutet (to CSF Compagnie Generale de Telegraphie). German Patent 1,181,342. Nov. 12, 1964. Priority date Sept. 4, 1962, [France].

A linear accelerator is described which facilitates a continuous variation of the exit energy of accelerated ions over a wide range. The accelerator comprises a drift tube waveguide and a meandering delay line connecting the two faces of the waveguide and crossing the ion path between the drift tubes. It is provided with perforations for the passage of the ions. The delay line is preferably a coaxial cable. The distance p between two neighboring drift tubes varies according to the equation $p = Az^{\frac{1}{2}}$, in which z is the distance from one end of the delay line to a predetermined homologous point on the delay line and A is a coefficient. (Gmelin Inst.)

Astrophysics and Cosmology

Refer also to abstracts 23197, 23332, and 23824.

23235 (SC-RR-64-967) THE THEORY OF TYPE I COMET TAILS. David B. Beard (Sandia Corp., Albuquerque, N. Mex.). Aug. 1964. Contract AT(29-1)-789. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Type I comet tails are shown to arise from the energetic electrons in the shock structure surrounding the head of a comet, once sufficient ionization of cometary gases has occurred to slow the magnetic lines of force trapped in the solar wind. The theory of the evolution of comet gases and the density distribution in the head are used to explain the inertial slowing down of the interplanetary field lines due to ionization of cometary molecules while in the magnetic field. The subsequent establishment of the ray structure by energetic electrons is shown quantitatively to follow very simply from energetic electrons resulting from the charge separation layer created by the shock structure on the comet head. (auth)

23236 SOLAR RADIO ASTRONOMY. A. Boischot and J. F. Denisse (Observatoire de Paris-Meudon, France). Advan. Electron. Electron Phys., 20: 147-98(1964).

The principles of radio emission and propagation in the solar atmosphere are summarized first. Thermal emission from the quiet sun is then briefly considered, together with experimental observations on the outer corona. The radio-emission related to sunspots and solar flares in the different frequency ranges is described, and the effects of this activity on the terrestrial environment are briefly discussed. 126 references. (D.C.W.)

23237 SOLAR RADIO BURSTS OF SPECTRAL TYPE V. A. A. Weiss and R. T. Stewart (CSIRO, Chippendale, New South Wales). Australian J. Phys., 18: 143-65(Apr. 1965).

The properties of the meter-wave type V burst were observed by interferometry in the frequency range 40 to 70 Mc/s and by dynamic spectroscopy in the frequency range 5 to 210 Mc/s. The investigations cover positions, movements, and angular sizes of the sources, and the spectrum and polarization of the emission. Characteristic spectral features of the type V burst are its association with type-III bursts (including inverted U bursts); large bandwidth; and duration (a slowly varying function of frequency) of a minute or so. There is no definite evidence for harmonic structure. In a minority of cases the type-V continuum is detached from the preceding type-III burst, thus giving a detached type-V burst whose properties differ in some respects from those of the more common attached bursts. Type-V sources occur at similar heights to type-III sources, lie within $\frac{1}{3}R_\odot$ of the associated type-III sources (except in the case of detached type V sources, which are usually greater than $\frac{1}{3}R_\odot$ from the type-III source), and show similar dispersion of position with frequency. About a third of the type-V sources show apparent movement on the disk, corresponding to speeds up to 2000 km/s. In size, also, the type-V is similar to the type-III source; the source size seems to be constant over the lifetime of the burst and the decay of intensity is exponential but some 10 times slower than for type-III bursts. The directivity of the radiation is very low in contrast to that for type-III bursts. The emission is only weakly polarized. A model of the type-V source, which accounts for most of the observed features, is suggested. In this model, coherent Čerenkov plasma waves are excited by fast electrons (speed $\sim\frac{1}{3}c$) ejected from a flare and oscillating between mirror points in a magnetic trap in the corona. (auth)

23238 THE NATURE AND VELOCITY OF THE SOURCES OF TYPE II SOLAR RADIO BURSTS. A. A. Weiss (CSIRO. New South Wales). Australian J. Phys., 18: 167-85(Apr. 1965).

The velocities of the sources of type-II bursts are derived from rates of frequency drift using standard density models, both statistically for 21 bursts, and individually for 5 bursts extending over wide frequency ranges. The derived velocities exceed the speed of sound in the magnetic-field-free corona: on the average the velocity decreases with increasing height to a minimum of ~750 km/sec at a little below 1 $R_\odot$, and thereafter slowly increases with height. The nature of the type-II source is discussed in relation to these velocities, and also in relation to detailed measurements of harmonic ratios and band splitting for the five individual bursts. It is suggested that the type-II source is either a strong parallel shock (direction of propagation of shock parallel to magnetic field) or a perpendicular shock. Magnetic field strengths of 2 to 20 gauss at 0.5 $R_\odot$ above the photosphere, decreasing 1 to 10 gauss at 2 $R_\odot$, are derived. Finally, it is shown that theories by which fundamental emission arises in front of the shock, whilst harmonic emission originates in the interior of the shock, are untenable. (auth)

23239 INTERDEPENDENCE OF SUNSPOT PROPER MOTIONS AND CHROMOSPHERIC FLARES. A. Antalova (Astronomical Inst., Slovak Academy of Sciences, Skalnate Pleso). Bull. Astron. Inst. Czech., 16: 32-8(1965).

Longitudinal acceleration and latitudinal acceleration were determined for 717 sunspots. An interdependence was found to exist between the acceleration values and the occurrence of flares in the 10° zone above the spots. The changes in the motions of the major spots in the active region were compared for 7 flares. Five of them were ribbon-shaped. It was found in these 5 cases that the sunspots above which the ribbon-shaped flare commenced had low values of acceleration and that the area of these spots diminished one day after the flare. In three cases, the ribbon-shaped flare ended above the sunspots. The acceleration of the spots was high in these cases, and the area increased the day after the flare. (auth)

23240 OBSERVATIONS OF CHROMOSPHERIC FLARES AT ONDŘEJOV OBSERVATORY DURING 1963. F. Krebík, J. Kvicala, L. Krivsky, J. Olmr (Astronomical Inst. Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 16: 38-44(1965).

A continuation is presented of nine preceding reports on chromospheric flares observed at Ondřejov from 1948 to the end of 1962 and covers the period of 1963. The data on 95 flares, associated 536 and 260 Mc events, and 27 Kc SEA observed and recorded during 1963 are summarized. The corresponding curves of the H_α line-width changes are plotted. (auth)

23241 THE MAGNETIC FIELD IN PLANETARY NEBULAE. II. THE PARTICLE PATH IN COMBINED MAGNETIC AND GRAVITATIONAL FIELDS. E. Chvojkova

(Astronomical Inst., Czechoslovak Academy of Sciences, Prague). Bull. Astron. Inst. Czech., 16: 49-53(1965).

It was previously assumed that a stationary polar cap, composed of charged particles, can hover in the highest parts of a stellar atmosphere for a long time, sustained there by the magnetic mirror. The trajectory of a charged particle spiralling along a magnetic field line is investigated, taking into account the variation of its kinetic energy produced by the movement in the gravity field. It appears that a particle spiralling along a magnetic field line which is almost parallel to the gravity field moves perpetually between two reflecting levels $r_{H,r}$ and $r_{g,r}$. The lower one is the magnetic mirror $r_{H,r}$; the upper is the highest distance which can be reached by a particle spiralling with given velocity in a field of gravity. However, the spiral motion along the equatorial magnetic loops is limited by the highest distance attainable by the magnetic line; thus the upper level of reflection $r_{g,r}$ often is insignificant there. The problem appears to be most interesting just below the escape velocity. This mechanism can perhaps explain the explosion of novae, since near to the escape velocity the upper reflecting level can decrease with increasing energy of the particles, thus acting against any expansion. Only when the energy exceeds a critical velocity does the upper reflecting level rise rapidly enough towards $r = \infty$ that the expansion looks like an explosion. (auth)

23242 THE DISTRIBUTION OF SOME NOBLE METALS IN METEORITES AND NATURAL MATERIALS. P. A. Baedecker and W. D. Ehmann (Univ. of Kentucky, Lexington). Geochim. Cosmochim. Acta, 29: 329-42(Apr. 1965).

Abundances of gold, iridium, and platinum were determined in a wide range of meteoritic and terrestrial materials. The technique of thermal neutron activation analysis couples the advantages of high sensitivity and freedom from reagent and laboratory contamination. Abundances of these elements in the chondrites were used to derive values for their cosmic atomic abundances. Implications of the data to theories of nucleosynthesis and the chemical history of meteorites and tektites are discussed. (auth)

23243 THE EARLY EVOLUTION OF THE SUN. Dilhan Ezer and A. G. W. Cameron (Goddard Inst. for Space Studies, New York). Icarus, 1: 422-41(Apr. 1964).

A series of models was developed, confirming the prediction of Hayashi that the early contracting sun is highly luminous and fully convective, if a correct choice is made of the photospheric boundary condition in constructing solar models in the contracting stages. The maximum radius of the protosun consistent with gravitational stability is 57 $R_\odot$ (solar radii), with a luminosity about 450 times that of the sun. As the protosun shrinks it stays fully convective to a radius of less than 3 $R_\odot$; the luminosity continues to decrease until a radius of 1.7 $R_\odot$ is reached. The sun requires about 2 million years to contract onto the main sequence. If the primitive solar material has the terrestrial ratio of deuterium to hydrogen, then a further 3×10^5 years is required to burn the deuterium. These values are much less than those of previous studies. Consideration is also given to the present abundance of lithium in the sun. This abundance is much smaller, relative to that of similar elements such as sodium or potassium, that is found for the earth and meteorites. Thermonuclear reactions with H above 4,000,000°K rapidly destroy Li. The outer convection zone of the sun probably became hot enough to cause a significant depletion of ^{6}Li, but the depletion of ^{7}Li is highly uncertain and depends on the details of the convection theory. These conclusions have considerable relevance for theories of the origin of the solar system, since it appears that planets forming in a solar nebula with the sun must be subjected to a high temperature environment. (BBB)

23244 MAGNETIC MEASUREMENTS NEAR VENUS. Edward J. Smith (California Inst. of Tech., Pasadena), Leverett Davis, Jr., Paul J. Coleman, Jr., and Charles P. Sonett. J. Geophys. Res., 70: 1571-86(Apr. 1, 1965).

Mariner-2 magnetometer data are presented. No magnetic fields attributable to Venus were detected. An upper bound on the magnetic dipole moment of Venus M_V is estimated in several ways, subject to uncertainties regarding the dipole orientation and the nature of the interaction between the solar wind and the planetary field. On the basis of Mariner's not entering the Venus magnetosphere, the upper bound lies between $\frac{1}{2}$ and $\frac{1}{8}$ of M_E, the earth's magnetic dipole moment. However, the absence of field fluctuations near Venus corresponding to the shell of disordered fields detected outside the earth's magnetosphere by satellites and space probes shows that M_V is less than M_E by at least an order of magnitude and makes it probable that M_V is less than $M_E/20$. This result is consistent with qualitative predictions based on the dynamo theory of planetary fields. The energy flux of cosmic radiation above the Venus atmosphere, except perhaps for cosmic rays of the lowest energies, should everywhere approximate the intensity in the earth's polar regions. Any radiation zone of trapped high-energy electrons is likely to be minor in comparison with the earth's. (auth)

23245 SOLAR-WIND MEASUREMENTS NEAR VENUS. Marcia Neugebauer and Conway W. Snyder (California Inst. of Tech., Pasadena). J. Geophys. Res., 70: 1587-91 (Apr. 1, 1965).

The velocity, temperature, and density of the protons in the solar wind are presented for the period when Mariner 2 was near Venus. From these data it is concluded that Mariner 2 never penetrated any magnetosphere associated with Venus; Mariner 2 was probably also outside any shock front associated with the supersonic motion of the solar wind past Venus; the solar-wind intensity was not especially great during the time of Venus encounter; any shock wave surrounding Venus was probably closer than about 25,000 km to the center of the planet at the subsolar point. (auth)

23246 SOLAR X-RAY OBSERVATIONS BY INJUN 1. J. A. Van Allen (State Univ. of Iowa, Iowa City), L. A. Frank, B. Maehlum, and L. W. Acton. J. Geophys. Res., 70: 1639-45(Apr. 1, 1965).

On the basis of 48 random observations of the sun from June through December 1961 with a thin mica window Geiger tube on satellite Injun 1, it was found that the quiet-day solar x-ray flux at 1 astronomical unit in the wavelength range $\lambda < 14$ Å had a minimum of 0.5×10^{-3} erg $(cm^2\ sec)^{-1}$, a value approximately independent of the assumed blackbody temperature of the emitting areas of the sun over the temperature range 0.8 to 8×10^6 °K. The solar x-ray flux underwent substantial time variation, from the lowest value quoted to the highest value on July 20 during a Hα flare of importance 3, when the flux $\lambda < 14$ Å was 0.07 erg $(cm^2\ sec)^{-1}$. Three other high intensity values also appeared to be associated with visual flares, but no convincing relation between intensity and flare activity was found among the other 44 cases. The median flux observed in the 48 random observations was 1.7×10^{-3} erg $(cm^2\ sec)^{-1}$ for $\lambda < 14$ Å. (auth)

23247 CYCLOTRON RADIATION: INTENSITIES OF HIGHER HARMONICS. R. Sugihara. Kaku Yugo Kenkyu, 10: 204-17(1963). (In Japanese)

The region with a refractive index $n \gg 1$ was analyzed on the basis of the thermal motion of plasmas. A relation for energy loss was derived from detailed calculations and indications for the longitudinal wave property of the dispersion relation are given. It is known from the relation for the intensities of higher harmonics at a constant field that β_T is proportional to ω_p^2. Thus the intensity of radiation increases with the current of electric discharge at elevated temperature. It is pointed out that the calculation showed stronger many-body correlation. Thus its result is different from the cyclotron radiation but, in view of its properties, is more similar to the Cherenkov radiation. It is expected that the intensity would fall rapidly when $S \geq 4$. In fact, $S = 2$ harmonics were clearly observed during bursts from the solar surface but few $S \geq 3$ harmonics are found and therefore they must be explained by calculations. (auth)

23248 A NEW METHOD FOR DEFINING THE OPTICAL DENSITY OF IONIZED HYDROGEN IN THE GALAXY. M. K. Eliass. Latvijas PSR Zinatnu Akad. Vestis, Fiz. Tek. Zinatnu Ser., No. 1, 75-8(1965). (In Russian)

A method is proposed for defining the optical density of the ionized hydrogen by comparing the distribution in the Galaxy plane and outside the plane. It is shown that this problem can be solved by using large antennas at frequencies below 85 mc. (auth)

23249 THERMODYNAMICS OF A SOLAR COMPOSITION GASEOUS MIXTURE. M. S. Vardya (Univ. of California, Berkeley). Monthly Notices Roy. Astron. Soc., 129: 205-13(1965).

Several thermodynamic quantities were calculated for a gaseous mixture of solar photospheric chemical composition containing hydrogen in five states—H_2^+, H_2, H, H^-, and H^+—helium and sixteen other elements in multiple ionization states and with radiation effects included. The discrepancy on various thermodynamic quantities of the neglect of H_2^+ and H^-, of metals and of radiation pressure was estimated. (auth)

23250 QUASARS AND ANTIMATTER. G. K. Gray and P. F. Browne. Nature, 206: 175-6(Apr. 10, 1965).

The asymmetrical evolution of optical isomers in naturally occurring substances is discussed as a close analog to the evolution of local pockets of matter and antimatter in the universe. The possibility that star-antistar annihilation may be the energy source for quasars is noted. (D.C.W.)

23251 CONVERGENCE AND DIVERGENCE IN GRAVITY AND MAGNETIC INTERPRETATION. B. S. R. Rao and I. V. Radhakrishnamurty (Andhra Univ., Waltair, India). Nature, 206: 179(Apr. 10, 1965).

The average radial gravity is defined as the arithmetic mean of all the gravity values lying on the circumference of a circle of radius r; a similar definition holds for the magnetic case. Considering the case of a sphere, it is shown that the series expansion $\bar{g}(r) = K/z^2 - 6Kr^2/4z^4 + 120Kr^4/64z^6 - 5040Kr^6/2304z^8$ for the average radial gravity vertically above its center diverges beyond a certain value of r which is related to the depth. (D.C.W.)

23252 AN EFFECT OF THE MAGNETIC FIELD IN THE SHOCK WAVE HEATING THEORY OF SOLAR CORONA. Yutaka Uchida (Tokyo Univ.). Publ. Astron. Soc. Japan, 15: 376-99(1963).

The shock-wave heating theory of the solar corona is extended to include magnetic-field effects, and theoretical models of the solar corona with and without the magnetic field are investigated. The solution for the corona is obtained numerically under given boundary conditions in the lowest chromosphere by using a model consistent with the heating and support of the chromosphere. This is made possible by considering the smallness of the net radiative loss per unit mass in the quasithermodynamical equilibrium in the lowest chromosphere. The presence of an outward decreasing magnetic field makes the effective sound velocity greater than in lower layers, thus weakening the strength of the shock waves and accordingly shifting the region of heat liberation out of the region of main radiation loss, which lies low near the chromosphere-corona transition layer. A greater downward heat flow by conduction is required by this separation, in turn demanding a steeper temperature rise to a higher value in the model than in the case without the magnetic field. The density in the corona remains higher due to the longer scale height in this case, and so features like coronal condensations on the plage regions around sunspots appear. (auth)

23253 METEORITES AND THE MOON. Harold C. Urey (Revelle Coll., La Jolla, Calif.). Science, 147: 1262-5 (Mar. 12, 1965).

Evidence accumulated during the last six years is reviewed, which indicates that some or possibly most of the stone meteorites come from the moon, including the carbonaceous chondrites of the Orgueil type. Models for the origin of the moon are consistent with the hypothesis that contamination of the moon by terrestrial waters and by some biological or prebiological material present at that time occurs. (L.B.S.)

23254 QUASI-STELLAR SOURCES AND GRAVITATIONAL COLLAPSE. Including the Proceedings of the First Texas Symposium on Relativistic Astrophysics, [Dallas, Dec. 1963]. Ivor Robinsin, Alfred Schild, and E. L. Schucking, eds. Chicago, University of Chicago Press, 1964. 488p. $10.00. (CONF-631202)

Papers (37) are included on experimental observations of quasi-stellar radio sources and theories of radio sources, particularly the theory of gravitational collapse of a superdense star. Reprints of seven other papers are also included. (D.C.W.)

Atomic Physics

Refer also to abstract 23738.

23255 (PAN-569/II) THE STUDIES OF AMMONIUM ION MOTIONS IN SOLID SOLUTIONS. Kazimierz Mikke and Ludwik Dobrzynski (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research). Nov. 1964. 17p. (CONF-804-29). Dep.

From Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 1964.

In order to study how the motion of the ammonium ion depends on the ammonium ion-ion interaction, the energy distribution of initially monochromatic neutrons scattered inelastically at 90° from solid solutions of ammonium iodide in potassium iodide were measured by the inverted filter method. Measurements were made at room and liquid nitrogen temperatures for two samples of concentrations of about 17 and 25% of NH_4I in KI. For these samples both in room and liquid nitrogen temperatures no peaks were observed, which suggest that ammonium ions rotate freely in these solutions. Analysis of these results showed that the sharp peak observed at liquid nitrogen temperature for pure NH_4I is due to a strong ammonium ion-ion interaction and suggests that the broad peak occurring at room temperature for pure NH_4I is connected with a torsional oscillation perpendicular to the rotation axis of the N—H—I^-. (P.C.H.)

23256 (UCRL-12408) THE POPULATIONS OF BOUND STATES OF HYDROGENIC IONS IN A STEADY STATE WITH NONTHERMODYNAMIC EQUILIBRIUM. William H. Grasberger (Lawrence Radiation Lab., Univ. of California, Livermore). Feb. 1965. Contract W-7405-eng-48. 26p. Dep.; $2.00(cy), 1(mn) CFSTI.

The departures of populations of one-electron ions from values determined by the condition of local thermodynamic equilibrium are treated. If collisions do not occur with sufficient frequency and if the radiation field departs noticeably from that of a blackbody the effect on the populations can be important. The concepts of kinetic equilibrium, radiative equilibrium, population invariance, cyclic line transitions, and conditions of a steady state are discussed. The energy diagram of hydrogenic ions, including fine structure, hyperfine structure, and the Lamb shift is also discussed. The complication of interlocking effects and coherent and noncoherent scattering is also mentioned. The condition of population invariance is derived in detail using the principle of detailed balance and the relation between Einstein coefficients. The equation of radiative equilibrium is also examined in detail. A simple model is proposed. The assumptions of kinetic equilibrium, steady state, no collisional transitions, and the noncyclic case for the transitions are made, which lead to the determination of the population of a given level by the condition that the rate of radiative ionizations from the level is equal to the rate of radiative recombinations to the level. Conditions for kinetic equilibrium, for neglecting cyclical line transitions, and for neglecting collisional transitions are presented. (auth)

23257 A METHOD FOR DETERMINING A SET OF EXPERIMENTAL SPHERICALLY SYMMETRICAL FORM FACTORS FROM X-RAY OR NEUTRON-DIFFRACTION

MEASUREMENTS. P. J. Brown and C. Wilkinson (Cambridge Univ., Eng.). Acta Cryst., 18: 398-400(Mar. 10, 1965).

A method is described for extracting a set of spherically symmetric form factors for the atoms in a structure, when a complete set of structure amplitudes for a single zone was measured. The method is applicable only when the atoms are resolved in projection. The calculation was programmed for the digital computer EDSAC II. (auth)

23258 DISSOCIATION OF METHANE MOLECULE IONS FORMED IN CHARGE EXCHANGE COLLISIONS WITH POSITIVE IONS. ION-MOLECULE REACTIONS OF METHANE. H. Von Koch (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 28: 529-38(1965).

Mass spectra of methanes (CH_4 and CD_4) were obtained after charge exchange with slow positive ions. The intensities of the peaks were plotted as a function of the energy absorbed by the molecule during the charge exchange. Integration of these curves gives a mass spectrum in reasonable agreement with that obtained in electron impact. The complete dissociation of the parent ion above 15 ev throws some doubt upon the determination of the higher ionization potential of methane from the break at 19.4 ev of the ionization efficiency curve for the production of the parent ion. The ion-molecule reaction $CH_4^+ + CD_4 \rightarrow CH_3 + CD_2H^+ + D_2$ indicates that in CH_4^+ all bonds are of approximately equal strength. (auth)

23259 DISSOCIATION OF ETHANE MOLECULE IONS FORMED IN CHARGE EXCHANGE COLLISIONS WITH POSITIVE IONS. ION-MOLECULE REACTIONS OF ETHANE. H. Von Koch (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 28: 559-74(1965).

Mass spectra of ethanes (C_2D_6, C_2H_6, and CH_3CD_3) were obtained after charge exchange with slow positive ions. The intensities of the peaks were plotted as a function of the energy absorbed by the molecule during the charge exchange. Integration of these curves gives a mass spectrum in reasonable agreement with that obtained in electron impact. The ion-molecule reactions observed at low velocity of the incident ion is $CHO^+ + C_2D_6 \rightarrow C_2D_6H^+ + CO$. The way in which the ion formed dissociates indicates that the ionized carbon in this intermediate ion must be considered as having the valency five with all bonds of approximately equal strengths. (auth)

23260 SOME COMMENTS ON THE AMO METHOD FOR THE GROUND STATE OF THE HYDROGEN MOLECULE. Osvaldo Goscinski and Jean-Louis Calais (Univ. of Florida, Gainesville and Uppsala Univ.). Arkiv Fysik, 29: 135-44 (1965).

For future applications to crystals the AMO method as applied to H_2 for small internuclear distances was studied. The AMO method was combined with a systematic scaling procedure, which is essential for small internuclear distances. The results show that the AMO method yields a lower energy than the MO method for all internuclear distances, provided that the total function is an eigenfunction of the total spin operator. Some comments are made concerning the construction of AMO's from different kinds of MO's. (auth)

23261 COMPARISON OF EXPERIMENTAL AND THEORETICAL RESULTS FOR IONIZATION CROSS SECTIONS OF INERT GASES. M. V. Kurepa. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 187-97(Oct. 1963).

Recent experimental ionization cross section data for inert gases were used to obtain cross section curves in the electron energy range up to 500 ev. These curves were compared with formulas based on classical theories. It is shown that the formulas given by Drawin and de la Ripelle are very useful for a quick computation of cross section values. They give cross sections of the right order of magnitude, the correct shape of the cross section curve and the maxima on the cross section against energy curves agree with experimental measurements. (auth)

23262 SENSITIZED FLUORESCENCE IN VAPORS OF ALKALI METALS. II. ENERGY TRANSFER IN POTASSIUM–ARGON COLLISIONS. G. D. Chapman and L. Krause (Univ. of Windsor, Ont.). Can. J. Phys., 43: 563-75(Apr. 1965).

Sensitized fluorescence in potassium, induced by argon at pressures between 0.01 and 350 mm Hg, was investigated to determine the cross sections for collisions of the second kind between potassium atoms in the 4^2P states and argon atoms in their ground states. The experiment was carried out at a potassium vapor pressure of 2×10^{-6} mm Hg at which there is no trapping of resonance radiation. The collision cross sections at very low argon pressures, at which the collision frequencies do not exceed one per average lifetime of the excited states, are $Q_1 = 10 \times 10^{-15}$ cm^2 for the $4\ ^2P_{\frac{1}{2}} \rightarrow 4\ ^2P_{\frac{3}{2}}$ transition and $Q_2 = 7.2 \times 10^{-15}$ cm^2 for the $4\ ^2P_{\frac{3}{2}} \rightarrow 4\ ^2P_{\frac{1}{2}}$ transition. At higher pressures, where the collisions are much more frequent, $Q_1 = 1.8 \times 10^{-15}$ cm^2, $Q_2 = 1.1 \times 10^{-15}$ cm^2, and $Q_1/Q_2 = 1.6$, in exact agreement with the principle of detailed balancing. The variation of the collision cross sections with argon pressure is ascribed to different transfer mechanisms predominating in the various pressure regions. (auth)

23263 THE RANGES OF ^{133}Xe AND ^{134}Cs IONS IN TUNGSTEN SINGLE CRYSTALS AND TUNGSTEN OXIDE AT ENERGIES OF 40 AND 125 kev. G. C. Ball and F. Brown (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys. 43: 676-83(Apr. 1965). (AECL-2171)

When ^{133}Xe and ^{134}Cs ions with energies of 40 or 125 kev are stopped in single crystals of tungsten, the tails of the range distributions are different; the Cs ranges are ~15% smaller. No significant difference exists in the ranges of these ions in amorphous WO_3. (auth)

23264 THE LUMINESCENCE OF THE OXYGEN EXCITED BY COLLISION OF PARTICLES ACCELERATED UNDER 500 kev. Maurice Dufay, Michel Druetta, and Michele Eidelsberg (Universite de Paris, Lyon). Compt. Rend., 260: 1123-6(Jan. 25, 1965). (In French)

The luminescence of oxygen bombarded by protons, deuterons or H_2^+ ions with energy of 500 kev was studied. The intensity of the rays of O I and O II observed in the spectral region from 3500 to 9000 Å increases linearly with the pressure. On the contrary, the bands of O_2^+ ($b^4\Sigma_g^- \rightarrow a_4\Pi_u$) are intense at the pressure of 15 μ of Hg and weak at 200 μ. There is then de-excitation by collision of the $b^4\Sigma_g^-$ level. This fact is reconciled by the low intensity of the bands of O_2^+ observed in the spectra of polar auroras. (tr-auth)

23265 EFFECT OF NITROGEN ON THE EMISSION OF LIGHT IN ARGON EXCITED BY α PARTICLES IN THE PRESENCE OF AN ELECTRIC FIELD. Jean-Louis Teyssier, Daniel Blanc, and Henri Brunet (Centre de Physique Nucleaire, Faculte des Sciences, Toulouse). Compt. Rend., 260: 1614-16(Feb. 8, 1965). (In French)

The modifications brought to the h(E) curves by the presence of nitrogen in argon (h is the pulse amplitude and E is the intensity of the magnetic field applied) was studied. In low concentrations, nitrogen favors the emission of light due to the electric field; on the contrary, in high concentrations, it inhibits the scintillation. (tr-auth)

23266 SHOOTING OF POTASSIUM IONS THROUGH THIN FILMS OF COPPER AND SILVER. E. M. Zarutskii (Leningrad Polytechnic Inst.). Fiz. Tverd. Tela, 6: 3734-6 (1964).

The depth of penetration and the character of deceleration of potassium ions shot through thin films of metals were studied. The procedure was the same as in previous work for lithium and sodium ions. The metal film thickness ranged from 150 to 400 Å, and the transmitted ions and emitted electrons were registered with a Faraday cup placed behind the film. The bombarding potassium ion energy reached 20 kev. Plots of the penetrability and of the range, as functions of the incident ion energy, are presented and analyzed. The measurements of the ion-electron and ion-ion emission and an analysis of the energy spectrum on the front side of the film showed that the particle emission is produced essentially in the surface layer and does not depend on the film thickness, having the same characteristics as for bulk metal. The range-energy curves did not agree with the theory of K. O. Nielsen because

Nielsen's calculations involve average ranges, but the experiment yielded maximum ranges. (ATD)

23267 A PROPOSED METHOD FOR ELECTRON IMPACT INELASTIC CROSS-SECTION MEASUREMENTS. J. M. Kurepa and M. V. Kurepa (Inst. of Physics, Belgrade). Intern. J. Electron. (1), 18: 115-24(Feb. 1965).

The experimental determination of cross sections for some processes of inelastic collisions between electrons and atoms, molecules or ions, as for example excitation of electronic and vibration energy levels, excitation of ions, dissociation of molecules into neutral fragments and so on, is not yet solved satisfactorily. A suggestion for an experimental method which will make possible the measurement of these quantities is given. The possibilities of the proposed apparatus are analyzed in detail. Special care is taken in the theoretical investigation of the analyzer with which the measurements could be done. (auth)

23268 ENERGY SPECTRUM OF THE 2^3S_1 STATE OF He^3 IN AN ARBITRARY MAGNETIC FIELD. G. V. Skrozkii and V. G. Pokazan'ev (Ural Polytechnic Inst., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1106-10(1964). (In Russian)

The energy spectrum of the metastable ground state of ^3He is studied. Calculations are made of the transition frequencies between the sublevels of the ground state in the presence of an external magnetic field; special attention is paid to the case of the weak field. (auth)

23269 TO THE THEORY OF OPTICAL ORIENTATION IN He^3. G. V. Skrozkii and V. G. Pokazan'ev (Ural Polytechnic Inst., USSR). Izv. Vysshikh Uchebn. Zavedenii,, Radiofiz., 7: 1111-21(1964). (In Russian)

The possibility of optical orientation in ^3He is considered. The related transition probabilities between the levels 2^3S_1 and $2^3P_{0,1,2}$ of orthohelium induced by the light of the resonance frequency are calculated. The signal and intensity of magnetization of the oriented helium atoms are calculated for the cases of a nonpolarized and polarized light propagating along the magnetic field. (auth)

23270 Hg ADSORPTION STUDIES USING ATOM EJECTION PATTERNS. G. S. Anderson (Litton Systems, Inc., Minneapolis). J. Appl. Phys., 36: 1558-61(May 1965).

The effect of Hg adsorption on atom ejection patterns in Hg^+ ion bombardment of Ni low-index planes was studied. The atom ejection patterns observed for single-crystal sputtering become smeared out when a Hg film is adsorbed on the target surface. The transition is unusually sharp and is interpreted to be the result of a two-dimensional condensation. A heat of adsorption of 0.69 ev/atom is derived from the model. The sputtering rate of the adsorbed Hg film seems to be determined more by the substrate than by the surface atom binding energy. (auth)

23271 SPUTTERING YIELDS OF ALKALI HALIDE SINGLE CRYSTALS BOMBARDED BY 2- TO 10-kev IONS. B. Navinsek (Nuclear Inst. "Jozef Stefan," Ljubljana, Yugoslavia). J. Appl. Phys., 36: 1678-9(May 1965).

Fresh (100) cleavage faces of sodium chloride, potassium chloride, potassium bromide, and lithium fluoride single crystals were bombarded by Ar^+ ions under normal incidence. Sputtering yields for these crystals in the energy range from 2 to 10 kev are between 0.30 and 2.15 atoms per ion. The ion bombardment apparatus and experimental conditions are briefly described. (auth)

23272 SPUTTERING OF SINGLE-CRYSTAL COPPER AND ALUMINUM WITH 20-600 ev ARGON IONS. F. J. Zdanuk and S. P. Wolsky (P. R. Mallory and Co., Inc., Burlington, Mass.). J. Appl. Phys., 36: 1683-7(May 1965).

Absolute measurement of the sputtering yield of (100) and (111) copper and of (111) aluminum single-crystal targets bombarded with 20–600 ev argon ions was performed employing a sensitive quartz microbalance in an ultrahigh-vacuum system. The threshold energies for copper and aluminum targets were less than 20 ev. The sputtering yield values in the threshold region were dependent upon the detailed nature of the target surfaces. The threshold region orientation dependence of the sputtering yield for copper was different from that in the higher energy regions. (auth)

23273 MULTIPLE IONIZATION IN NEON, ARGON, KRYPTON, AND XENON. Fred A. Stuber (Mellon Inst., Pittsburgh). J. Chem. Phys., 42: 2639-43(Apr. 15, 1965). (RRL-146)

The ionization probabilities of Ne, Ar, Kr, and Xe were measured with electron energies up to 2000 ev. Ions with charge up to 5 for Ne, 6 for Ar, 8 for Kr, and 9 for Xe were observed, and their ionization potentials are reported. (auth)

23274 LONG-RANGE INTERACTION IN TWO-ELECTRON SYSTEMS. W. J. Carr, Jr., and M. Ashkin (Westinghouse Electric Corp., Pittsburgh). J. Chem. Phys., 42: 2796-2801(Apr. 15, 1965).

The methods of Gor'kov and Pitayevski and Herring and Flicker for calculating the exact exchange interaction in a well-separated two-electron system were examined in more detail, and attention was given to the wavefunction. An attempt was made to apply the method to a case approximating two electrons in the electron gas problem as well as to the hydrogen molecule. In the case of hydrogenic systems, it was concluded that the usual Heitler–London method is satisfactory for giving the exchange energy since there is a natural "cutoff" separation beyond which the exchange is of little interest, and up to this separation no important difference exists between the exact and the Heitler–London results. The "cutoff" is reached when the purely magnetic energy becomes equal to the exchange. However, differences between the exact and the Heitler–London wavefunctions can be significant, and an approximate form is discussed, which may be of value in variational calculations for more involved systems. (auth)

23275 GAUGE INVARIANCE OF THE HARTREE-FOCK APPROXIMATION. Saul T. Epstein (Univ. of Wisconsin, Madison). J. Chem. Phys., 42: 2897-8(Apr. 15, 1965).

Gauge invariance in the presence of nonlocal potentials is reviewed. It is shown that the uncoupled Hartree–Fock method is not gauge invariant. Gauge invariance of variational calculations is reviewed and it is shown that the coupled Hartree–Fock approximation is gauge invariant. A procedure for choosing a best gauge is suggested and in a special case is shown to reduce to a method recently proposed by Karplus and Kolker. (auth)

23276 SELECTION RULES IN EXCITATION BY ELECTRON IMPACT. Edwin N. Lassettre (Mellon Inst., Pittsburgh). J. Chem. Phys., 42: 2971-2(Apr. 15, 1965).

It is shown that selection rules for excitation, by electron impact, of both atoms and molecules hold in the second Born approximation as well as the first. A numerical illustration is provided by the calculations of Pomilla and Shapiro on the transition 2S → 3S in atomic hydrogen. (M.C.G.)

23277 APPROXIMATE ANALYTICAL WAVEFUNCTIONS FOR Xe AND Rn. Miroslav Synek and George E. Stungis (DePaul Univ., Chicago). J. Chem. Phys., 42: 3068-70(May 1, 1965).

Approximate analytical wavefunctions were calculated for the atoms Xe and Rn. The minimum basis set expansion used made the wavefunctions sufficiently simple for orientational calculations. The Hartree-Fock total energies are represented to three significant figures. The virial theorem and the SCF thresholds are quite satisfactory. (auth)

23278 IONIZATION OF H_2 BY ELECTRON IMPACT NEAR THRESHOLD. Donald D. Briglia and Donald Rapp (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Chem. Phys., 42: 3201-13(May 1, 1965).

The cross section for ionization of the hydrogen molecule by electron impact near threshold was experimentally studied in a total-ionization tube. Careful attention was given to consistency checks to ensure complete collection of electrons and ions. The cross section was found to be essentially a linear function of the electron-energy excess above threshold for ~4 ev above threshold. Similar results

were obtained using a d-c electron beam, and using a double-phase sensitive detection a-c variation of the RPD method to reduce the energy spread to ~0.06 ev at half-height. These results were in disagreement with the threshold law predicted by a simple direct-ionization model, and implied that some indirect process such as autoionization plays a major role in the ionization process. Thus the distribution of vibrational states in H_2^+, which plays a major role in inelastic collisions of H_2^+ with atomic particles, is not correctly predicted by the direct ionization model. (auth)

23279 TEMPERATURE DEPENDENCE OF THE RATE OF CONVERSION OF He^+ INTO He_2^+. Franklin E. Niles and W. W. Robertson (Univ. of Texas, Austin). J. Chem. Phys., 42: 3277-80(May 1, 1965).

Measurement of the decay of atomic and molecular emission in the early helium afterglow for temperatures from 77 to 449°K and pressures from 3.76 to 9.93 Torr, together with the known value for the ambipolar diffusion of He^+, showed that the temperature dependence of the conversion frequency for the reaction $He^+ + 2He \rightarrow He_2^+ + He$ goes as T^{-1}. When the conversion frequency is expressed as βp^2, the quantity βT^3 is independent of temperature and pressure with an average value of $2.97 \times 10^{33}°K^3\ sec^{-1} \cdot Torr^{-2}$. When the conversion frequency is expressed as $k_R[He]^2$, the quantity $k_R T$ is independent of temperature and pressure with an average value of $3.19 \times 10^{-29}°K \cdot cm^6\ atoms^{-2} \cdot sec^{-1}$. Theoretical considerations confirmed that the temperature dependence of the conversion frequency goes as T^{-1}. (auth)

23280 ATOMIC-BEAM MEASUREMENTS OF VAN DER WAALS FORCES. Erhard W. Rothe and R. H. Neynaber (General Dynamics/Convair, San Diego, Calif.). J. Chem. Phys., 42: 3306-9(May 1, 1965).

It was expected that the strength of the van der Waals potential ($-C/r^6$ term) may be calculated from measurements of the total scattering cross section Q if the collision is sufficiently low energy. Unfortunately, experimental values obtained for C were about a factor of 2 higher than those predicted by theory. This discrepancy would be resolved if experimental Q's were about 30% lower. A systematic experimental error, which may account for the high values for Q is discussed. This error is the Ishii–Nakayama pumping effect, which occurs in the normal use of McLeod gauges. This error in measurements of Q for scattering metastable helium and neon in rare gases were estimated. The resulting C's, and corrected C's for previously published alkali scattering, no longer include the factor of 2 discrepancy. Comparisons are made with other experiments. (auth)

23281 VELOCITY DEPENDENCE OF THE TOTAL CROSS SECTION FOR THE SCATTERING OF METASTABLE $He(^3S_1)$ BY HELIUM, ARGON, AND KRYPTON. Erhard W. Rothe, R. H. Neynaber, and S. M. Trujillo (General Dynamics Convair, San Diego, Calif.). J. Chem. Phys., 42: 3310-14(May 1, 1965).

The velocity (v) dependence of the total cross section (Q) was measured for the scattering of helium in the metastable 2^3S_1 state by ground-state helium, argon, and krypton at relative velocities in the range from 1000 to 3300 m/sec. The results were compared with those previously obtained for the scattering of lithium. For each scattering gas, the shape of Q(v) was similar to that of lithium, but the absolute values for Q were approximately 20% higher. The scattering was largely elastic. It was estimated that the inelastic contribution to Q is about 10% for the He^*-He case, and that it is less than 3% for the He^*-Ar and He^*-Kr cases. The Q(v) for scattering by argon and krypton showed undulatory behavior. From the extrema velocities, the product $\epsilon\sigma$ is shown to be close to that for Li scattering, where ϵ is the depth of the interatomic potential well and σ is the interatomic separation at the zero of the potential. The separate parameters ϵ and σ were also deduced. A minimum to the number of diatom bound states was established for $HeAr(^3\Sigma^+)$ and $HeKr(^3\Sigma^+)$. (auth)

23282 RESONANCE ABSORPTION SPECTROPHOTOMETRY OF THE HYDROGEN ATOM BEHIND SHOCK WAVES. A. L. Myerson, H. M. Thompson, and P. J. Joseph (Cornell Aeronautical Lab., Inc., Buffalo). J. Chem. Phys., 42: 3331-2(May 1, 1965).

The hydrogen atom concentration behind shocks in $Ar-H_2$ mixtures was followed quantitatively by atomic resonance absorption spectrophotometry. Preliminary values for the specific dissociation rate constants were calculated. The measured rates were found to be higher than calculated, but by a factor that decreased radically with increasing temperature. (M.C.G.)

23283 DETERMINATION OF THE MOST IMPORTANT RADIATION CORRECTION TERMS FOR THE GROUND STATE OF THE HYDROGEN MOLECULE. J. Ladik (Central Research Inst. for Chemistry, Hungarian Academy of Sciences, Budapest). J. Chem. Phys., 42: 3340-1(May 1, 1965).

The effect of the most important radiation-correction (Lamb shift) energy terms on the binding energy of the hydrogen molecule was investigated. (M.C.G.)

23284 YIELD OF THE COSTER-KRONIG $L_I \rightarrow L_{III}$ TRANSITION FOR ELEMENTS OF ATOMIC NUMBER BETWEEN 73 AND 92. J. G. Ferreira, M. O. Costa, M. I. Goncalves, and L. Salgueiro (Laboratoire de Physique, Faculte des Sciences, Lisbon and Laboratoire de Physique, Faculte des Sciences, Porto, Portugal). J. Phys. (Paris), 26: 5-8(Jan. 1965). (In French)

The Coster-Kronig yield f_{13} of Ta, W, Ir, Pt, Au, and Tl was determined by comparing the relative intensities of the L x-ray lines with the L_α and $L_{\beta 2}$ satellites. (auth)

23285 RELAXATION THROUGH COLLISIONS OF EXCITED STATES OF AN ATOM. Alain Omont (Universite de Paris). J. Phys. (Paris), 26: 26-40(Jan. 1965). (In French)

The theory of interatomic collisions, in the sudden approximation, is generalized in order to calculate their influence on the evolution of the density matrix of atomic excited states of a vapor. One takes in account the dipolar electrostatic interaction only and its first (resonant) and second-order (non resonant) terms. To average the effects of one collision, a development of the density matrix in standard components of irreducible tensor operators is used in a systematic way; this simplifies the definition and the calculation of cross-sections and relaxation times corresponding to different observables. The theory is extended to the case of odd isotopes by supposing that a collision affects the electronic part of the atomic wave function only. Finally, the results of the above theory are compared to those of different experiments (double resonance, depolarization of resonance radiation, excitation transfer from one isotope to another ...) concerning triplet levels of mercury, cadmium, and zinc (Hg–Hg, Cd–Cd, Zn–Zn and Hg-noble gases collisions). (auth)

23286 ON THE TRANSITION PROBABILITY IN IONIZATION OF ATOMS BY COLLISION. Masatake Mori and Hiroshi Fujita (Tokyo Univ.). J. Phys. Soc. Japan, 20: 432-7(Mar. 1965).

Approximate formulas for some basic quantities in transition between a discrete state and the continuum in collision problems are given with error estimates. For the matrix of the interaction it is assumed that only the elements corresponding to the transition between the discrete state and the continuum have nonzero values. (auth)

23287 SECONDARY ELECTRON EMISSION OF VACUUM-CLEAVED SOLIDS. N. R. Whetten (General Electric Research Lab., Schenectady, N. Y.). J. Vacuum Sci. Technol., 2: 84-8(Mar.-Apr. 1965).

Recent work on the secondary electron emission properties of solids with less than .01 of a monolayer of absorbed gas on the surface is reviewed. The solids were cleaved in a high vacuum so that secondary emission measurements could be completed in a time that was short compared to the monolayer adsorption time. The solids include graphite, NaCl, KCl, NaBr, KBr, and KI. The gases released from the alkali halides at the moment of cleavage were analyzed with a partial pressure analyzer. (auth)

23288 ON THE Li ATOM IONIZATION BY NEUTRON COLLISION. R. Kh. Propin. Latvijas PSR Zinatnu Akad. Vestis, Fiz. Tek. Zinatnu Ser., No. 6, 9-14(1964). (In Russian)

The ionization of the Li atom is investigated in a sudden perturbation approximation. It is found that ionization through two intermediate atomic states $1s2s2p^2P$ is of great importance for the general ionization probability. (auth)

23289 THE ATOMIC HYDROGEN MASER. Norman F. Ramsey (Harvard Univ., Cambridge, Mass.). Metrologia, 1: No. 1, 7-15(Jan. 1965).

The atomic hydrogen maser is described in which device hydrogen atoms in the upper hyperfine state are focused onto the entrance aperture of a teflon-coated quartz bulb in which the atoms are stored for about a second. This bulb is surrounded by a cylindrical radiofrequency cavity. When the cavity is tuned to the hyperfine frequency of atomic hydrogen, maser radiation is produced. Due to the large line Q resulting from the long storage time, the radiation is highly stable in frequency. Results are given of theoretical calculations on the threshold flux of atoms required for maser oscillations, on the various relaxation processes that limit the effective storage time, and on the possible sources of frequency shifts of the maser. Results are given on the relative stability of two hydrogen masers. Measurements of the atomic hyperfine frequency of atomic hydrogen and deuterium give Δ_H = 1,420,405,751.800 ± 0.028 cps and Δ_D = 327,384,352.5 ± 1.0 cps on the A.1 time scale with Δ_{Cs} = 9,192,631,770.0 cps. The method by which the deuterium was measured depends upon the effect of a deuterium magnetic resonance transition upon the intensity of the hydrogen maser oscillation amplitude when a mixture of hydrogen and deuterium is used. This method should be capable of extension to a number of different atoms. The hydrogen maser apparatus was used to measure the spin exchange collision cross section between atomic hydrogen and a number of different gases. Results of some of these measurements are reported. Measurements of the dependence of the hydrogen hyperfine frequency upon a strong externally applied electrostatic field are given. (auth)

23290 SINGLE BI-PARTICLE ELASTIC COLLISIONS OF FAST PROTONS WITH METALS. Rafi Mohammed Chaudhri, Mustafa Yar Khan, and M. Munawar Chaudhri (Government Coll., Lahore). Nature, 205: 997-8(Mar. 6, 1965).

Analyses were made on ions emitted by bombardment of metals with energetic protons and ions. It was established that fast protons and molecular hydrogen ions make single bi-particle elastic collisions with atoms lying on a metal surface where they behave as if they are effectively isolated from the lattice. The technique used to locate the emitted ions is described. (P.C.H.)

23291 HOW CRYSTALS CHANNEL FAST IONS. M. W. Thompson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). New Scientist, 26: No. 437, 28-9(Apr. 1, 1965).

Some experiments which verified the channeling of fast ions in crystals are reviewed; and the effects of channeling on physics experiments are considered, together with experimental uses of channeling. (D.C.W.)

23292 MEASUREMENTS OF THE LINEAR POLARIZATION OF ELASTICALLY SCATTERED GAMMA RAYS. M. Singh and B. S. Sood (Punjabi Univ., Patiala, India). Nucl. Phys., 64: 502-12(Mar. 1965).

Measurements are described of the linear polarization of elastically scattered gamma rays from a lead scatterer. The results indicate that an incomplete resolution of incoherent scattering from coherent scattering tends to lower the values of the observed polarization. The measured values of the polarization of the elastic scattering of 280, 662, and 1250-kev gamma rays at different scattering angles are found to agree with the theoretical values of Brown and Mayers. In contradiction with earlier suggestions, it is found that the effect of L shell contributions is small and that it can not account for the large deviations reported previously. The present results remove the discrepancy between the experiment and theory. (auth)

23293 DETERMINATION OF SCREENING ANGLES FROM MULTIPLE-SCATTERING EXPERIMENTS IN GASES. J. Kessler (Technische Hochschule, Karlsruhe, Ger.). Phys. Letters, 15: 307-8(Apr. 15, 1965).

Results of previous experiments on electron scattering in noble gases are used to determine screening angles. It is emphasized that any result on the screening angle is valid only in a limited range and that the values given hold only in the region of plural scattering into small angles. (C.E.S.)

23294 DOUBLE CHARGE TRANSFER He^{++} + He. Margaret J. Fulton and Marvin H. Mittleman (Univ. of California, Livermore). Phys. Rev., 138: A667-9 (May 3, 1965). (UCRL-12183)

A model, previously discussed, in which electron correlation in helium is neglected, is used to calculate the double-charge-transfer cross section for He^{++} in He. The model yields a double-charge-transfer probability which is the product of two single-charge-transfer probabilities. The single-transfer probability is calculated by a Born approximation and a modified Born approximation. The one existing experiment is in satisfactory agreement with the latter. (auth)

23295 ELECTRON-ALKALI-ATOM INTERACTION POTENTIAL AND ELASTIC-SCATTERING CROSS SECTION. J. C. Crown (Pratt and Whitney Aircraft, East Hartford, Conn.) and A. Russek. Phys. Rev., 138: A669-82(May 3, 1965).

The potential energy between an incident electron and a neutral alkali atom was calculated using first-order perturbation theory in the adiabatic approximation. The results are shown to be expressible in terms of a multipole expansion suitably generalized to allow for the penetration of the target-atom wave function by the incident electron. The monopole and dipole contributions were calculated in detail for cesium. For large separations, the monopole contribution to the potential is small compared to the dipole contribution but becomes increasingly significant at smaller separations. For infinite separation, the calculations can be interpreted to yield the atomic polarizability, and the result for cesium (61.0 $Å^3$) is in reasonable agreement with experimental results. With this interaction potential, the elastic scattering of low-energy electrons from neutral cesium is treated in the adiabatic approximation with exchange. For purposes of comparison, the nonexchange approximation is also treated. (auth)

23296 RADIATIVE LIFETIMES AND EXCITATION MECHANISMS IN HELIUM. W. R. Pendleton, Jr., and R. H. Hughes (Univ. of Arkansas, Fayetteville). Phys. Rev., 138: A683-7(May 3, 1965).

The radiative decay rates of the $n^1S(n = 4,5)$, 3^1P, $n^1D(n = 3,4,5)$, $n^3S(n = 4,5)$, $n^3P(n = 3,4,5)$, and $n^3D(n = 3,4)$ states of helium were measured using pulsed, variable-energy electron-impact excitation and a sampling method of detection. The results agree well with previously published measurements. Experimental evidence is presented for the mechanisms involved in the collisional-transfer reactions where atoms in ^1P states excite ^3D levels; nF levels ($n \geq 5$) are populated by collisional transfer from n^1P levels and in turn cascade to the ^3D levels. Possible laser action in the $3^1P \rightarrow 3^1S$ and $5F \rightarrow 3^3D$ transitions is suggested. (auth)

23297 STOPPING POWER OF GASES FOR LITHIUM IONS. S. K. Allison, D. Auton, and R. A. Morrison (Univ. of Chicago). Phys. Rev., 138: A688-91(May 3, 1965). (COO-238-45)

The molecular stopping powers of the bases H_2, He, CH_4, N_2, and CO_2 for lithium-6 ions in the kinetic-energy range 0.6 to 3.75 Mev were measured to ±5%. The ratio of the molecular stopping powers for ^6Li to previously known values for protons of equal velocity indicates that the effective charge of 3.75-Mev ^6Li ions is 2.7 in H_2 and 2.9 in CO_2.

This indication from stopping powers is essentially the same as the effective beam charge obtained by Teplova et al. by magnetic analysis of a lithium beam which has passed throush a celluloid foil; but at lower velocities magnetic analysis and stopping-power ratios do not give concordant estimates of the effective charge. (auth)

23298 ANGULAR DISTRIBUTION OF SPECULARLY REFLECTED X RAYS FROM THIN FILMS. O. J. Guentert (Raytheon Co., Waltham, Mass.). Phys. Rev., 138: A732-6(May 3, 1965).

The angular distribution of specularly reflected x rays from thin films was studied. For incident angles Θ_i larger than the critical angle Θ_c the reflected radiation consists of three distinct parts: the specular beam itself; an anomalous beam near Θ_c; a low-intensity interference pattern extending from about Θ_c through the specular beam to higher angles. The two latter contributions can be attributed to small-angle scattering originating at the film surface and at the film-substrate interface. The shape of the specular beam varies periodically as a function of Θ_i. This phenomenon is due to interference between truly specular components and scattered components. The scattered radiation accompanying specularly reflected x rays and its effect on the specular beam are sensitive indicators of the smoothness of both the film surface and the film-substrate interface. (auth)

23299 EFFECT OF ELEVATED TEMPERATURES ON SPUTTERING YIELDS. C. E. Carlston, G. D. Magnuson, A. Comeaux, and P. Mahadevan (General Dynamics/Convair, San Diego, Calif.). Phys. Rev., 138: A759-63(May 3, 1965).

A study was made of the effect of elevated temperatures on the sputtering yields of polycrystalline and single-crystal metals. The temperature range extended from 350 to 1000°K. The yield determinations were made by standard weight-loss techniques. The bombarding ions were Ar^+ with energies 2, 5, and 10 kev. The face-centered-cubic polycrystalline Cu and Al targets showed essentially no change in yield with temperature. This is to be contrasted with the polycrystalline body-centered-cubic targets Mo, W, and Ta which showed linear increases in yield of 26, 28, and 39%, respectively. A Mo(100) crystal face showed no change in yield over the temperature range, but a Mo(110) face showed a 12% increase in yield. On the other hand, a Cu(110) crystal showed no change in yield with temperature, while a Cu(111) face showed a decrease in yield of 24, 12, and 16% at 2, 5, and 10 kev, respectively. (auth)

23300 MEASUREMENT OF CESIUM AND RUBIDIUM CHARGE-TRANSFER CROSS SECTIONS. Julius Perel, Richard H. Vernon, and Howard L. Daley (Electro-Optical Systems, Inc., Pasadena, Calif.). Phys. Rev., 138: A937-45 (May 17, 1965).

Charge-transfer cross sections for all cesium and rubidium ion-atom combinations were measured over energy ranges of 0.2 to 21 kev and 0.4 to 30 kev for the resonance and nonresonance combinations, respectively. A crossed-beam technique was used in which the atom beam was modulated by a mechanical chopper. Slow ions, produced by charge-transfer collisions, were extracted at the crossed-beam interaction region and detected using phase-sensitive lock-in techniques. Surface ionization was used to generate the ion beams and to detect the atom beams. The resonance cross sections are in general agreement with other experimental determinations and with theoretical predictions, except for the appearance of structure in the cross-section curves. The nonresonance cross sections show the expected adiabatic increase with velocity with the maximum near 10^{-14} cm^2 for Rb^+-Cs at a velocity of 23×10^6 cm/sec. The Cs^+-Rb maximum is also expected to occur at this velocity, which is just beyond the measured range. For each nonresonance cross section, four subsidiary peaks were observed below the velocity at the maximum. The two curves are similar in shape, with all of the Cs^+-Rb peaks occuring at the same velocities as the Rb^+-Cs peaks. The low-velocity portion of our Rb^+-Cs measurements is in good agreement with the data of Marino as regards the magnitude of the cross sections and the location of the first subsidiary peak. The cross-section curves of the four combinations are in very good agreement with the theoretical predictions of Rapp and Francis, particularly the ion velocity at the maximum for Rb^+-Cs. The subsidiary peaks appear to be related to electron transitions between the first excited states of the incident and product atoms. Incident-atom excited states are attributed to polarization excitation by the incident ion during the initial phases of the collision, and it is concluded that the atomic polarizability greatly affects the magnitude and shape of the cross-section curves. (auth)

23301 RADIO-FREQUENCY RESONANCE OF THE METASTABLE STATE $(2^2P_{\frac{1}{2}}\ 3^2S_{\frac{1}{2}})_2$ OF NEON PRODUCED AND ALIGNED BY ELECTRON IMPACT. Tetsuo Hadeishi, Orilla A. McHarris, and William A. Nierenberg (Univ. of California, Berkeley). Phys. Rev., 138: A983-6(May 17, 1965). (UCRL-11825)

The metastable state $(2^2P_{\frac{1}{2}}\ 3^2S_{\frac{1}{2}})_2$ of neon was produced and aligned by electron impact. The diode-structure electron gun was operated at a high electron-current density under space-charge neutralization conditions. Radio-frequency resonance of the aligned metastable state $(2^2P_{\frac{1}{2}}\ 3^2S_{\frac{1}{2}})_2$ was observed by monitoring the change of absorption of the λ6143-resonance radiation passing through the gap between the cathode and anode. The neon metastable-state resonance was compared with the mercury metastable-state 6^3P_2 radio-frequency resonance obtained by using the same gun for both, and observed by monitoring the absorption of the λ5461-resonance radiation passing through the same excitation region. The observed $(g_J)_{Ne}/(g_J)_{Hg}$ was 1.008 ± 0.024. This method could be applied to other atoms having a metastable state with $J > 0$. (auth)

23302 FORMULA FOR THE ASYMMETRY IN DOUBLE SCATTERING OF FAST ELECTRONS BY THOMAS-FERMI-DIRAC FIELD. T. Tietz (Indiana Univ., Bloomington). Phys. Rev., 138: A998-9(May 17, 1965).

The calculation of the asymmetry in the double scattering of fast electrons by a Thomas-Fermi-Dirac field is discussed. (auth)

23303 SMALL-ANGLE MULTIPLE SCATTERING OF ELECTRONS AND POSITRONS AND COMPARISONS BETWEEN MOLIERE AND ROZENTAL SCREENING. Robert D. Reed (Ling-Temco-Vought Research Center, Dallas). Phys. Rev., 138: A1000-2(May 17, 1965).

A comparison between the Molière and Rozental representations of the Thomas-Fermi function is made and the small-angle multiple-scattering distribution functions for these representations are calculated on the basis of the work of Reed and Nodvik. The 1/e widths of the distribution functions thus obtained are compared to the experimental results of Hanson, Lanzl, Lyman, and Scott. No appreciable difference is found between the results of the two representations. The difference in the multiple scattering between electrons and positrons is also calculated and the results are compared to the cloud-chamber experiments of Strong and Roy. The multiple scattering is predicted quite accurately for small-angle scattering of both electrons and positrons. However, the agreement with percentage difference between electrons and positrons is marginal. (auth)

23304 INTERPRETATION OF $Ar^+ - Ar$ COLLISIONS AT 50 Kev. U. Fano (National Bureau of Standards, Washington, D. C.) and W. Lichten. Phys. Rev. Letters, 14: 627-9(Apr. 19, 1965).

Results of coincidence experiments on $Ar^+ - Ar$ inelastic collisions are studied to obtain information concerning atomic and molecular mechanics. The $Ar^+ - Ar$ system is considered as a molecular ion, Ar_2^+, and its independent electron molecular orbitals are examined in the Born-Oppenheimer approximation. It is suggested that the gross structure of the spectra of energy dissipation reflects the shell structure of the colliding atoms; dissipation stems primarily from the electron promotion mechanism of molecular orbital theory and is followed by autoionization; and a test of this interpretation is provided by the spectrum of ejected electrons. (L.B.S.)

23305 ENERGY LEVELS OF Pr^{3+} IN THE VAPOR STATE. Jack Sugar (National Bureau of Standards, Washington, D. C.). Phys. Rev. Letters, 14: 731-2(May 3, 1965)

An analysis of the emission spectrum of triply ionized praseodymium in the vapor state resulted in the determination of all the energy levels of the ground $4f^2$ configuration except for the $^1S_0$ level. These data provide the opportunity for a direct experimental determination of the crystal field on the free ion energy levels of the rare earths. (C.E.S.)

23306 EFFECTS OF MULTIPLE STIMULATION IN THE INTERACTION OF SEVERAL BOSON WAVES. G. Mayer (Compagnie Generale de Telegraphie sans Fil, Orsay, France). Phys. Status Solidi, 9: 73-8(1965). (In French)

The elementary interaction process between light and matter is studied in which the number of bosons produced can be some units higher than the number of incident bosons. These interactions are often too weak to be detected experimentally under normal conditions, but can become important if the excitation intensity is high enough to allow the stimulation effects to become important. The case in which the interaction of a photon and molecule gives rise to several phonons and one photon is discussed in detail. Reference is made to stimulated Raman effects and laser systems with positive gain. (auth)

23307 ROTATIONAL ANALYSIS OF 2620Å AND 2760Å BANDS OF $^{32}S^{34}S$. N. A. Narasimham and Kum. Mukta N. Bhagvat (Atomic Energy Establishment, Trombay, India). Proc. Indian Acad. Sci., Sec. A, 61: 75-9(Feb. 1965).

Rotational analysis of bands of $^{32}S^{34}S$ at 2620Å and 2760Å was made, confirming the earlier vibrational assignment of these bands. The band origins and isotope shifts of these bands are given. (auth)

23308 THE ANGULAR DISTRIBUTION OF SPUTTERED PARTICLES FROM POLYCRYSTALLINE PLANE GOLD TARGET BY IMPACT WITH POSITIVE IONS OF ARGON. V. T. Chiplonkar and S. R. Rane (Inst. of Science, Bombay). Proc. Indian Acad. Sci., Sect. A, 61: 100-12 (Feb. 1965).

The angular distribution of the sputtered atoms under impact of positive argon ions (3-7 kev) from a plane polycrystalline target of gold was observed for various angles of impact and ion energies. The sputtered atoms were simultaneously collected on two cylindrical collectors—in the incident plane by collector I and in a plane perpendicular to it by collector II. Pronounced maxima were found for the deposit on collector I for certain preferred directions, giving evidence for the single collision mechanism in sputtering. The angular distribution of the deposit on collector II was observed to be approximately of the cosine type; it was however under-cosine for low ion energies and over-cosine for higher energies. The distribution of the deposit on collector I was studied at various lateral distances y from the axis of the collector and was shown to become of the cosine type for large y. Experimental evidence is given to show that under the experimental conditions sputtering by the multicollision mechanism is predominant. (auth)

23309 ISOTOPIC SHIFTS FOR Sn^{116}, Sn^{118}, Sn^{120}. I. I. Agarbiceanu, V. S. Tatu, N. T. Comaniciu, and V. V. Draganescu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 637-44(1964).

Fabry-Perot interferometer and Schüler lamps were used to measure isotope shifts in the lines SnI λλ 2863.33 and 2839.9 Å for the following enriched samples of Sn isotopes: ^{116}Sn(86.0%), ^{118}Sn(94.0%), and ^{120}Sn(94.1%). A compensation between the mass isotopic effect and the volume isotopic effect is expected in this atomic number region. The results of measurements are in satisfactory agreement with theoretical considerations. (auth)

23310 SOME CONSIDERATIONS ON HIGH-FREQUENCY ION SOURCES. G. Semenescu and D. R. Ionescu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 939-50(1964). (In Russian)

The results obtained by studying a high-frequency ion source are presented. The manner in which the parameters of the ion source (pressure, generator power, and the extraction voltage) affect the beam intensity was determined. Magnetic analysis of the extracted beam showed that the H^+ ions constitute about 80% of the total intensity. In the conditions used, during the functioning of the ion source, the largest part of the power absorbed by the discharge was used for excitation and about 25% for ionization of the hydrogen atoms. A beam with an intensity of 800 μamp was obtained for an absorbed power of 45 w and an extraction voltage of 4.8 kv; the gas output was about 11.5 atm cm^3/hr. (tr-auth)

23311 MOLECULAR BEAM SPECTROSCOPY. K. F. Smith and P. J. Unsworth (Univ. of Sussex, Eng.). Sci. Progr. (London), 53: 45-59(Jan. 1965).

An account is presented of the general way in which molecular beams are produced and detected, followed by a discussion of some of the more important applications of molecular-beam spectroscopy. These include the measurement of nuclear moments and spins, the Lamb shift and free electron moment, the neutron moment, the electric and magnetic properties of simple molecules, and the hydrogen and ammonia masers. (auth)

23312 IONIZATION OF ELECTRON OUTSIDE THE NUCLEUS BY β-DECAY. C. Watanabe. Soryushiron Kenkyu, 27: 258-64(1963). (In Japanese)

The effect on β spectra of the ionization of electrons outside the nucleus produced by β-decay is discussed. The phenomenon is caused by two processes, the direct collision process and the shaking process. The influence of the ionization on the β spectrum when the loss of energy by β particles is larger is calculated in terms of Feinberg's theory, and the matrix element causing the transition of ionization is written. The ratio of probabilities for the two processes are obtained for ^{32}P, ^{35}S, ^{90}Sr-^{90}Y, ^{147}Pm, and RaE. Theoretical results are compared with direct measurement of the ionized electrons, and the ionization probability for the atomic K shell was obtained for Z = 20 to 60. It is concluded that the Langer effect cannot be effectively described by the second electron emission. (L.B.S.)

23313 THE EXPERIMENT OF SHAKE-OFF ELECTRONS. M. Ishihara. Soryushiron Kenkyu, 27: 265-8 (1963). (In Japanese)

Three experiments on electron shake-off are considered. The measurement of x rays produced as a result of holes appearing in the electron orbits from excitation and ionization of the atom by electron shake-off is described, and the results of Miqdal and Levinger are presented. The distribution of electric charge of residual atoms for ^{85}Kr, measured by Shell with a charge spectrometer, is considered; and the corresponding values for the ionization of the N shell and the K + L + M shells are compared with the values calculated in terms of Hartree wave functions by Green. It is concluded that the Langer effect cannot be described by the effect of shake-off electrons. (L.B.S.)

23314 AN INVESTIGATION OF THE CONNECTION BETWEEN THE APPROXIMATIONS SUITABLE FOR THE CALCULATIONS OF SLOW AND FAST COLLISIONS OF ATOMIC SYSTEMS. Yu. E. Murakhver. Vestn. Leningr. Univ., No. 22, Ser. Fiz. i Khim., No. 4, 50-5(1964). (In Russian)

The results of Bates concerning the effect of quasimolecule rotation on the rotation between approximations for the calculation of low- and high-velocity collisions of atomic systems are generalized. In the case of excitation processes, the perturbed-stationary-state method and perturbation theory taking into account distortion and nonorthogonality are shown to coincide at medium velocities, if the initial and final orbital and magnetic quantum numbers are equal. For electron capture this coincidence occurs only for s-s transitions. (auth)

23315 SCATTERING OF ELECTRONS ON MERCURY ATOMS IN THE ENERGY REGION 200 TO 4000 ev. Joachim Kessler and Hans Lindner (Technische Hochschule, Karlsruhe, Ger.). Z. Physik, 183: 1-9(1965). (In German)

Angular distributions for the single scattering of 200- to 4000-ev electrons were measured over a wide angular range and compared with recent calculations, the accuracy of which is theoretically hard to assess. The scattering intensity being continuously recorded, even fine details of the angular distributions were obtained accurately. The calculations of Holzwarth and Meister turned out to be correct even in these details. (auth)

23316 DECOMPOSITION PROPERTY OF THE SLATER DETERMINANT. Edward B. Jay (Hughes Aircraft Co., Culver City, Calif.). Z. Physik, 184: 175-80(1965).

The first step in solving the atomic many-body problem is the independent-particle, or Hartree-Fock method. This leads to the formulation of the system eigenfunction in terms of a single Slater determinant (neglecting correlations). By defining a matrix, the elements of which are the one-particle orbitals occurring in the Slater determinant, a method is developed whereby the wave function is written as a polynominal in the eigenvalues of the matrix. This method, when used in conjunction with the variational principle, reduces the arithmetic tedium usually resulting in the Hartree-Fock method. The numerical results are in agreement with the Hartree-Fock method (to within 1.5%) and within 1.56% of the exact values for a seven-electron atom. (auth)

23317 TEMPERATURE AND TIME DEPENDENCE OF DELAYED ELECTRON EMISSION. Joseph Specht and Werner Klein (Universitat, Heidelberg). Z. Physik, 184: 233-40(1965). (In German)

Occupied traps responsible for delayed electron emission show an exponential decay. From the form of a single glow maximum, one can determine the temperature dependence of the decay constant of the traps of one sort. The decay constant is shown to have the form $\lambda(T) = \lambda_0 \exp(-\epsilon/kT)$. The two parameters λ_0 and ϵ — characteristic of one glow maximum — were determined from the shape of the glow curve with a linear increase of temperature with time for an aluminium specimen. From the saturation of the glow maxima with the excitation one can determine an exciation cross section. (auth)

23318 EFFECTIVE CROSS SECTION FOR ELASTIC AND INELASTIC ELECTRON SCATTERING ON AMORPHOUS CARBON AND GERMANIUM FOILS. W. Bruenger and W. Menz (Universitat, Hamburg). Z. Physik, 184: 271-85(1965). (In German)

Absolute intensities of electrons scattered by amorphous carbon and germanium foils were measured for various energies (20–60 kev) and foil thicknesses (200–800 Å). Electrons scattered elastically were separated from those scattered inelastically by means of a retarding field. Thus total cross sections for elastic and for inelastic scattering were obtained. Agreement of observed and theoretical values is satisfactory, especially regarding the dependence on electron energy. (auth)

23319 CHEMICAL SHIFT OF THE K-SERIES X-RAY LINES FROM TIN. O. I. Sumbaev and A. F. Mezentsev (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 445-53(Feb. 1965). (In Russian)

The shifts of the $K_{\alpha 1}$, $K_{\alpha 2}$, and $K_{\beta 1}$ $Sn-SnO_2$ lines are measured with a Cauchois diffraction spectrometer with luminescent registration and supplied with a device for alternate introduction into the instrument of the sources being compared. The results obtained are $E^{Sn} - E^{SnO_2} = -0.19 \pm 0.01$, -0.18 ± 0.02, and -0.22 ± 0.02 ev for $K_{\alpha 1}$, $K_{\alpha 2}$, and $K_{\beta 1}$ respectively. The relative accuracy is 0.00006%. By making use of the L_{III} level shift of $Sn-SnO_2$ previously determined and found to be -1.1 ± 0.3 ev, the shifts of the K, L_{II} and M_{III} levels relative to the Fermi level are determined and the results are -1.3 ± 0.3, -1.1 ± 0.3, and -1.1 ± 0.3 ev respectively. The feasibility of employing a similar method for observing isotopic and isomeric x-ray shifts and also effects connected with motion of the source and its recoil during emission or absorption of quanta are considered. (auth)

23320 DETECTION OF HeH_2^+ IONS AND LONG-LIVED HIGHLY EXCITED MOLECULAR AND ATOMIC STATES. S. E. Kupryanov (Karpov Inst. of Physics and Chemistry, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 467-75(Feb. 1965). (In Russian)

It is shown that highly excited long-lived states of the molecules and atoms of hydrogen and the atoms of helium, neon, argon, krypton, and xenon are formed in collisions between electrons and the hydrogen molecules or atoms of the noble gases. Highly excited long-lived states of nitrogen, oxygen, hydrogen, and carbon atoms are formed in collision between electrons and nitrogen, oxygen, water, and ethylene molecules. Besides the well known ions, HeH_2^+ ions were detected in a helium–hydrogen mixture. (auth)

23321 PROBLEMS AND RESULTS OF THE STARK EFFECT IN RESEARCH ON LIGHT AND MATTER. R. Gebauer. p.71-88 of "Physikertagung Hamburg." Mosbach/Baden, Ger., Physik Verlag, 1964. (In German)

The still-unresolved problems of the classical Stark effect are reviewed. The discovery of this effect, the principal methods of observation, and the technical carrying out of the transverse field apparatus for precision measurements are described. Frequency alterations and the intensity distribution in the splitting of the Balmer lines are discussed. The metal Stark effect is considered in conclusion. (J.S.R.)

23322 EFFECT OF THIN CARBONACEOUS FILMS ON 500 Kev HELIUM ION SPUTTERING OF COPPER. Harold P. Smith, Jr. (Univ. of California, Berkeley), D. W. DeMichele, and J. M. Khan. New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-71, 21p, $1.00. (CONF-650108-13) (UCRL-12022)

From AIAA 2nd Aerospace Sciences Meeting, New York.

A radioactive tracer technique capable of measuring less than 10^{-10} grams of copper was developed. A 500 kev magnetically analyzed beam of helium ions was used to observe the sputtering yield as a function of carbonaceous film thickness over a copper target. It is shown that an amorphous film of the order of 2×10^{17} atoms/cm^2 reduces the sputtering yield of copper by a factor of 100. A first collision model of sputtered atom penetration of the film is in good agreement with the data and yields a copper-carbon cross section of 3×10^{-17} cm^2. A clean surface sputtering yield of 2×10^{-2} atoms/ion is obtained by extrapolation of the data and is consistent with the yield of 800 kev H_2^+ sputtering of copper reported by Kaminsky (Phys. Rev. 126: 1267 [1962]). It is postulated that ordering of the amorphous film occurs for areal densities greater than $2 \times 10^{+17}$ atoms/cm^2 on the basis that the rate of reduction of copper yield with increasing film thickness undergoes a sharp decrease at that point. (auth)

23323 POSITRON-HYDROGEN SCATTERING AT LOW ENERGIES. Richard J. Drachman (Goddard Space Flight Center, Greenbelt, Md.). 29p. (CONF-641004-7)

From American Physical Society, Chicago.

The complete Dalgarno-Lynn second-order adiabatic potential was used to compute the elastic scattering of positrons on hydrogen below the threshold for positronium formation. The corresponding zero-order problem is investigated using the monopole part of the adiabatic potential. A comparison with the 1s-2s close-coupling results produces an estimate of the extent of monopole suppression required to simulate the non-adiabetic effects. An appropriate modification of the potential gives excellent agreement with Schwartz's s-wave results. Higher partial waves and the bound-state problem are also investigated. (auth)

23324 THEORY OF ELASTIC DIFFERENTIAL SCATTERING IN LOW ENERGY He^+ + He COLLISIONS. Raymond P. Marchi and Felix T. Smith (Stanford Research Inst., Menlo Park, Calif.). 42p. (CONF-641210-11)

From American Physical Society Meeting, Berkeley, Calif.

The elastic differential scattering of He^+ in He is calculated at the barycentric energies 15, 50, and 300 ev for comparison with the experiments of Lorents and Aberth. Available computed potentials of the g and u states of He_2^+ dissociating smoothly to ground state $He^+ + He$ are used. The quantal interference pattern is reproduced by applying the principle of superposition to the classical scattering amplitudes appropriate to the pure g and u states-amplitudes whose magnitudes and phases are given by classical integrals over the trajectories corresponding to the g and u potentials separately. The interference takes place at the common angle and usually involves different values of the angular momentum in the two states. Non-zero minima occur even in two-state elastic scattering because the two interfering terms may differ in magnitude. A secondary interference at large angles is identified as an effect of nuclear symmetry that should disappear in an experiment using two different isotopes. It is likely that all the details seen in the elastic scattering experiments at these energies can be accounted for quantitatively by the two-state theory, but to explain the data at the lowest energies and those at the largest angles would require knowledge not now available of the behavior of the potentials at large and small R. (auth)

23325 TRANSFER OF EXCITATION ENERGY IN HELIUM BY ATOMIC COLLISIONS. Tsu-wei Nee and Robert M. St. John (Univ. of Oklahoma, Norman). 10p. (CONF-641016-3).

From 17th Annual Gaseous Electronics Conference, Atlantic City.

The multiple-state transfer process of helium was clarified and extended through the comparison of predictions with recent absolute measurements of helium excitation functions at several pressures. Atoms excited to an n^1P level are converted to a mixed singlet-triplet F state by an atomic collision. Low-lying singlet and triplet levels are fed by the many F states thusly populated. Apparent excitation functions were computed by machine for the 3^3D, 4^3D, 3^1D, and 4^1D states and were compared with experimental curves of the 3^3D, 4^3D, and 4^1D states at four pressures. The calculations were based on a variety of assumptions relating to the variation of the transfer cross section with the principal quantum number n, and to the mixed F state model. The computed functions best match the experimental curves when it is assumed that the transfer cross section for the nth set of ^1P-F states is proportional to the first power of n, and that the $^1F_3$ and $^3F_3$ components of the mixed state are active in the transfer-cascade processes, while the $^3F_{2,4}$ states are inactive. The energy is primarily transferred through n^1P-nF sets of states with $n \leq 15$. (auth)

23326 PROTON-EXCITED X-RAYS AND APPLICATIONS. Andrew A. Sterk (American Machine and Foundry Co., Alexandria, Va.). 17p. (CONF-641017-5)

From Symposium on Low Energy X and Gamma Sources and Applications, Chicago.

Some of the characteristics of x-ray generation by proton bombardment are described. With work still in progress, it has been proven that this method is particularly suitable for soft x-rays >10 Å. Excitation efficiencies are equal to or better than with electron excitation, while the resulting spectrum consists of a single characteristic radiation line, but with complete absence of bremsstrahlung. Experimental results, the design of an instrument, and some applications are discussed. (auth)

23327 CROSS-SECTIONS FOR CHARGE-EXCHANGE REACTIONS. $H^+ + H(n_1l_1m_1) \rightarrow H(n_2l_2m_2) + H^+$. Robert M. May (Univ. of Sydney). 40p. (CONF-641108-21)

From American Physical Society, New York.

The cross sections for the formation of final excited states in reactions of the type $H^+ + H(n_1l_1m_1) \rightarrow H(n_2l_2m_2) + H^+$ are calculated. The contributions to the cross sections from the final angular momentum states are also obtained, and the case in which the initial hydrogen atom is in the ground state is treated. (D.C.W.)

Cosmic Radiation

See also Elementary Particles and Radiations. Nuclear Properties and Reactions.

Refer also to abstract 23363.

23328 (AFCRL-64-743) A STUDY OF THE SCINTILLATION-RATE SPECTRUM OBSERVED IN THE AURORAL ZONE. Scientific Report No. 9. Ludwik Liszka (Kungliga Vetenskapsakademien, Kiruna (Sweden). Geofysiska Observatoriet). July 20, 1964. Contract AF61(052)-678. 24p. (AD-606648). $1.00(CFSTI).

A study of the scintillation-rate spectrum of satellite signals at 54 Mc observed at Kiruna, Sweden (67.8° N, 20.3° E) is presented. Temporal variations in the scintillation-rate spectrum, in particular the occurrence of slow and fast scintillation, are investigated. (auth)

23329 SOLAR FLARES AND COSMIC RAY STORMS IN MAY AND JULY 1959. B. Trumpy, T. Svanes, and J. Stadsnes. Arbok Univ. Bergen, Mat.-Nat. Ser., No. 15, 1-39(1965).

The results of investigations on the modulation effects on different components of cosmic rays during the active solar flare periods in May and July 1959 are presented. In addition to the registrations of the nuclear and meson components at the station of Bergen, a comprehensive material from a great number of stations in Europe, U.S.A., Argentine, Canada, South and East Africa, Japan and Australia has been used in order to classify the results on the basis of possible modulation theories. (auth)

23330 FLUX AND ENERGY SPECTRUM OF LOW-ENERGY COSMIC RAY PROTONS. K. Kristiansson (Univ. of Lund, Sweden). Arkiv Fysik, 29: 23-32(1965).

A spectrum of protons in the energy interval 25–150 Mev is studied in a nuclear emulsion block which was exposed in a Nike-Cajun rocket launched from Kronogård in northern Sweden. The exposure was made at a time of low solar activity. The integral momentum spectrum of the protons can approximately be expressed by the formula $J = J_0 e^{-p/p_0}$ where J_0 = 11,000 protons/m^2/sec/sterad and p_0 = 75 Mv. The spectrum is discussed and compared with solar flare proton spectra. (auth)

23331 THE RELATIVE ABUNDANCE OF NUCLEI HEAVIER THAN HELIUM IN PRIMARY COSMIC RADIATION NEAR THE GEOMAGNETIC EQUATOR. O. Mathiesen and A. Stenman (Univ. of Lund, Sweden). Arkiv Fysik, 29: 145-65(1965).

Photometric measurements were made on 89 tracks of heavy primary particles ($Z > 2$), which were found in an emulsion stack exposed at Guam near the geomagnetic equator. The measurements were corrected for different emulsion effects. The standard error in the charge determination was found to be about 0.25 units of charge. The charge calibration was made by measurements of δ-ray and blob densities and by studying suitable break-up events. The observed spectrum was divided into three groups: $L(3 \leq Z \leq 5)$, $M(6 \leq Z \leq 9)$, and $H(Z \geq 10)$. These were extrapolated to the top of the atmosphere. The ratios of nuclei in different charge ranges were determined and compared with determinations at other latitudes. A three-dimensional diffusion model of particle propagation was found to account for the observed energy dependence of the ratio of light ($3 \leq Z \leq 5$) to medium ($6 \leq Z \leq 9$) nuclei, assuming that soft magnetic clouds are responsible for the diffusion mechanism. (D.C.W.)

23332 FLIGHT TIME OF SOLAR COSMIC AND PROTON RADIATION TO THE EARTH. L. Krivsky (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 16: 27-32(1965).

Ejection of solar cosmic radiation or protons that produce the PCA (polar-cap absorption) effect is considered to originate in flares with a Y-shaped development phase

at the time of rapid blaze up. Thus the exact time of the ejection and escape of the particles, coincident with the first peak of cm or dm radio emission, is known. The time lag of the beginning of the PCA effect or of the beginning of the increase of cosmic radiation after the occurrence of the Y-shaped phase in the respective flare is determined. With cosmic radiation the delay ranges between 3 and 85 minutes (+8 minutes for light); with particles producing the PCA effect it ranges from 10 to 870 minutes (+8 minutes for light). (auth)

23333 LOW-ENERGY NUCLEAR BURSTS OF COSMIC RAYS AT SEA LEVEL. S. R. Ganguly and S. D. Chatterjee (Jadavpur Univ., Calcutta). Indian J. Phys., 38: 499-508 (Oct. 1964).

Measurements of cosmic-ray bursts in a thin-wall unshielded ionization chamber at Calcutta (sea level) are described. Bursts due to nuclear interactions are isolated from those due to air showers by counter coincidence method. The integral size-frequency distribution of nuclear bursts can be represented by a power law with exponent 3.4. The energy of an incident particle initiating a nuclear burst of a given size is evaluated, using previous results of energy measurements of star prongs in photographic emulsions. The energy spectrum of cosmic particles producing bursts at sea level is constructed, and it is found that it can be represented by an empirical relation: $N(E) = 240.E^{(-.72-.89 \log E)}$ within the energy range investigated, from 50 Mev to about 1 Bev. (auth)

23334 ON LOW-FREQUENCY SPECTRUM OF COSMIC RADIO EMISSION. S. Ya. Braude and V. V. Vaisberg (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian SSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1032-40(1964). (In Russian)

The low-frequency ($\nu < 10$ Mc) spectrum of cosmic radio emission is studied, considering it as the result of the absorption of the halo synchrotron radiation in the ionized H of the galactic disk. Because of the irregular distribution of H II in the disk, it may be expected that the deviation of the emission index (characterizing the absorption level) in a given direction from the emission indices in other directions follows a random law (within the limits of the directional pattern of the radiotelescope). Parameters of the emission-index distribution computed on the basis of results of observations testify that the intensities of cosmic radiation at frequencies $\nu < 10$ Mc measured using antennas of different directivity can differ greatly from one another. Thus the associated fluctuations must depend on the frequency and reach 37% of the intensity of the halo radio emission. (auth)

23335 RESUMEN DE LABORES. PUBLICACIONES DEL LABORATORIO DE FISICA COSMICA. UNIVERSIDAD MAYOR DE SAN ANDRES. (Review of Works. 1963. Publications of the Laboratory of Cosmic Physics. Universidad Mayor de San Andres). Publ. Lab. Fis. Cosmica, Univ. Mayor San Andres, No. 26, 1-108(Nov. 1964).

The progress report for the year 1963 of the Laboratory of Cosmic Physics is presented. The results of fourteen studies are given, and the publications by laboratory personnel are tabulated. Individual abstracts of some of the papers were prepared. (J.S.R.)

For abstracts of individual papers see: 22550, 23336, 23337, and 23338.

23336 DENSITY SPECTRUM OF EXTENSIVE SHOWERS AT 5200 METERS ABOVE SEA LEVEL. J. Rivas (Universidad Mayor de San Andres, La Paz, Bolivia). Publ. Lab. Fis. Cosmica, Univ. Mayor San Andres, No. 26, 22-5(Nov. 1964). (In Spanish)

The exponent in the density spectrum of extensive air showers at an altitude of 5200 m is 1.48. The calculations made to obtain this value are described and discussed. (auth)

23337 TIME VARIATIONS IN CHACALTAYA IN 1963. O. L. Troncoso (Universidad Mayor de San Andres, La Paz, Bolivia). Publ. Lab. Fis. Cosmica, Univ. Mayor San Andres, No. 26, 26-32(Nov. 1964). (In Spanish)

The experimental equipment, operational, under construction, or being designed, for measurement of the time variations in the cosmic radiation at Chacaltaya is described. The solar and geomagnetic disturbances observed from July to November 1963 are graphed and briefly discussed. The data obtained with the directional telescope are reviewed. The methods used for data processing are considered. (J.S.R.)

23338 DESIGN OF AN EXPERIMENT WITH COSMIC RADIATION TO INVESTIGATE STRONG INTERACTIONS WITH ENERGIES OF THE ORDER OF 300 Bev. L. W. Jones (Univ. of Michigan, Ann Arbor). Publ. Lab. Fis. Cosmica, Univ. Mayor San Andres, No. 26, 88-95(Nov. 1964). (In Spanish)

A cosmic-radiation experiment to investigate strong interactions in order to obtain data on some of the basic problems of these interactions is designed. The scope of cosmic physics pertaining to synchrocyclotrons is to be studied simultaneously. The precise purpose of the experiment is to determine the diffraction of the elastic p-p scattering and obtain a definitive determination of the line-width parameter of the diffraction peak in p-p scattering. The parameters of the experiment are tabulated. (J.S.R.)

23339 THE STUDY OF THE REGION OF COSMIC RAY AND REGGEIZATION OF MULTIPERIPHERAL MODEL. K. Oyakawa. Soryushiron Kenkyu, 27: 345-8 (1963). (In Japanese)

The experimental results obtained in a study of the cosmic ray region at squared energy of $\sim 5000(\text{Bev})^2$ in the center of mass system are presented. The multicenter and Regge behavior and the boson chain model are discussed. (L.B.S.)

23340 COSMIC RAY PHYSICS. A. E. Sandstroem. Amsterdam, North-Holland Publishing Company and New York Interscience Publishers, 1965. 429p.

Composition of the primary cosmic radiation and the production of secondary components are discussed. Instruments for intensity measurements are surveyed. Effects of the atmosphere and the earth's magnetic field are considered. The optics of cosmic-ray recording systems are reviewed. Intensity-time variations and their relation to solar activity are described. Extensive air showers and trapped radiations are described. Possibilities for the origin of cosmic rays are discussed. 339 references. (M.J.T.)

23341 THE IMPORTANCE OF RADIATION ANISOTROPY IN DOSE CALCULATIONS. R. E. Fortney and G. D. Duckworth (Northrop Space Labs., Hawthorne, Calif.). 12p. (CONF-720-16)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

The interaction of anisotropy of geomagnetically trapped charged particles and space vehicle orientation for a wide range of material distributions was investigated. The basis for the study was a space experiment with three solid-state detectors located at different depths in a sphere of aluminum. (M.C.G.)

23342 AN EXPERIMENTAL EXAMINATION OF LOW-ENERGY COSMIC RAY HEAVY NUCLEI. C. E. Fichtel, D. E. Guss, and K. A. Neelakantan (Goddard Space Flight Center, Greenbelt, Md.). 40p. (CONF-452-79)

From American Physical Society, Washington, D. C., Apr. 1964.

In a sounding rocket experiment flown from Fort Churchill on September 4, 1963, a finite flux of cosmic-ray nuclei with charges greater than that of helium was detected at energies below the experimental energy cutoff of balloon-borne experiments. The particles were examined by extending large sheets of nuclear emulsions from the sides of the rocket during its period outside the atmosphere. The flux of medium nuclei ($6 \leq Z \leq 9$; Z = nuclear charge) in the energy range from 30 to 150 Mev/nucleon was measured as 0.67 ± 0.13 particles/(m^2sr sec), and the flux of ($10 \leq Z \leq 19$) nuclei in the energy range

from 40 to 190 Mev/nucleon was 0.31 ± 0.09 particles/(m^2sr sec). A finite flux of light nuclei ($3 \leq Z \leq 5$) also was seen in the 30 to 110 Mev/nucleon region. The abundances of medium and ($10 \leq Z \leq 19$) nuclei relative to helium nuclei in the same energy intervals were found to be significantly less than the relative abundances previously determined at high energies. However, within the statistical uncertainty, the relative differential flux values observed in the vicinity of the earth are consistent with the helium, medium, and ($10 \leq Z \leq 19$) nuclei having the same source spectrum at least above about 0.2 Bev/nucleon for a wide range of source spectral shapes and an interstellar path length of the order of those normally assumed (i.e., 2.5 g/cm^3 or slightly larger). Other possible interpretations also are considered. (auth)

Direct Energy Conversion

Refer also to abstracts 23861, 23991, 24046, and 24064.

23343 (AE-175) ANALYSIS OF LINEAR MHD POWER GENERATORS. E. A. Witalis (Aktiebolaget Atomenergi, Stockholm (Sweden)). Feb. 1965. 38p. Dep. (mn).

The finite-electrode-size effects on the performance of an infinitely long MHD power generation duct are calculated by means of conformal mapping. The general conformal transformation is deduced and applied in a graphic way. The analysis includes variations in the segmentation degree, the Hall parameter of the gas, and the electrode-insulator length ratio, as well as the influence of the external circuitry and loading. A general criterion for a minimum of the generator internal resistance is given. The same criterion gives the conditions for the occurrence of internal current leakage between adjacent electrodes. It is also known that the highest power output at a prescribed efficiency is always obtained when the current is made to flow between exactly opposed electrodes. Curves are presented showing the power-efficiency relations and other generator properties as depending on the segmentation degree and the Hall parameter in the cases of axial and transverse power extraction. The implications of limiting the current to flow between a finite number of identical electrodes are introduced and combined with the condition for current flow between opposed electrodes. The characteristics of generators with one or a few external loads can then be determined completely. Examples are given in a table. It is shown that the performance of such generators must not necessarily be inferior to that of segmented generators with many independent loads. However, the problems of channel end losses and off-design loading have not been taken into consideration. (auth)

23344 (IPP-3/26) TWO-DIMENSIONAL ANALYSIS OF MHD GENERATORS WITH SEGMENTED ELECTRODES. Z. N. Celinski and F. W. Fischer (Institut fur Plasmaphysik, G.m.b.H., Garching (West Germany)). Jan. 1965. 80p. Dep.(mn).

The distribution of electrical parameters in MHD generators was determined by numerical analysis for any channel geometry and any practical Hall parameter. The analysis was limited to generators with a separate electrical circuit for each pair of electrodes. Constant gasdynamic parameters and constant generator cross section were assumed. A correction factor was calculated, the use of which makes it possible to correct one-dimensional theory equations for two-dimensional effects. Optimum electrode sizes were determined. (auth)

23345 (NP-14891) SEGMENTED ELECTRODE LOSSES IN MHD GENERATORS WITH NONEQUILIBRIUM IONIZATION. [PART] II. Research Report 201. Jack L. Kerrebrock (Avco-Everett Research Lab., Everett, Mass.). Jan. 1965. 38p.

In MHD generators designed to produce nonequilibrium ionization by electron heating, the electrical conductivity may be very high near segmented electrode walls, where the concentrated dissipation produced by blockage of the conduction current at the surface of the insulator may produce much higher electron temperatures than exist in the bulk of the gas. The nonuniform conductivity tends to cause Hall current shorts which increase the dissipation and the conductivity near the electrodes. The effect of this phenomenon on the performance of segmented electrode generators is analyzed, with the principal aim of predicting the electron temperature rise in such devices. One conclusion of the analysis is that generators with rather coarse segmentation are less subject to this type of loss than are generators with very fine segmentation, and will therefore yield larger electron temperatures. A second conclusion is that, to maximize the electron temperature rise, operation at high Mach number, but rather low Hall parameter, is desirable. While there is not sufficient experimental data to properly verify these conclusions, the available data are consistent with them. (auth)

23346 (NP-14919) CURRENT STATUS OF MHD POWER GENERATION: ITS PROMISES AND PROBLEMS. Scientific Paper 62-118-266-P4. T. C. Tsu and L. S. Frost (Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.). Oct. 17, 1962. 18p.

Problems under investigation include plasma conductivity, strong magnetic fields, and real machine effects. The difficulties of both thermal and non-thermal ionization are discussed. Strong magnetic fields are expected to influence the MHD process in several ways: the Hall effect; tensor conductivity; ion slip; and certain hydrodynamic effects. These, as well as some real machine effects, are dealt with briefly. (auth)

23347 (NYO-3429-2) THE DEVELOPMENT OF AN IMPROVED THERMIONIC ENERGY CONVERTER. Quarterly Technical Report No. 2. (Radio Corp. of America, (Lancaster, Pa. Direct Energy Conversion Dept.)). Jan. 15, 1965. Contract AT(30-1)-3429. 32p. Dep.; $2.00(cy), 1(mn) CFSTI.

Activities in a program to determine the feasibility of reservoirless converters by conducting a series of tests on operating thermionic converters which contain Cs in the vapor phase only are reported. Reservoirless converters are being tested to determine variations in performance during operating life times, and the effects of envelope temperature variations on converter performance. A program is planned to use radioactive tracer techniques to determine where and to what extent incompatibilities exist within the converter system. The isotope ^{134}Cs is used to fill test converters, and established radioactive tracer techniques are then used to determine the distribution of Cs within the converter and the rate of diffusion into the exposed materials. The emphasis during the reporting period was directed toward improved processing techniques, improvement of heater design, evaluation of converter performance with radioactive and nonradioactive Cs, evaluation of variable-volume converter performance, life testing of reservoirless converters, and the analysis of converter components. (J.R.D.)

23348 A CRITERION FOR APPLYING LOW VALUES OF MAGNETIC REYNOLDS NUMBER IN INDUCTION MAGNETOGASDYNAMIC GENERATORS. J. Milewski (Inst. of Fluid-Flow Machines, Polish Academy of Sciences, Danzig). Bull. Acad. Polon. Sci., Ser. Sci., Tech., 12: 933-8(1964).

A criterion for avoiding the limitation of high values of the magnetic Reynolds number in induction-type MHD generators is specified in the course of an analysis of particular generator variants. (D.C.W.)

23349 THERMIONIC ENERGY CONVERTER IN MAGNETIC FIELD. J. Faehnrich and E. Tomkova (Charles Univ., Prague). Czech. J. Phys., 15: 276-86(1965).

The influence of a magnetic filed on the function of a thermionic energy converter is discussed. A relation for the effect of the magnetic field on the converter current in a diffusion regime is derived, and measurements for a quasi-vacuum and diffusion regime of the converter are given. (auth)

23350 FUELS FOR ADVANCED POWER GENERATION SYSTEMS. S. Way, W. E. Young, I. S. Tuba, and R. L.

Chambers (Westinghouse Electric Corp., Pittsburgh). J. Eng. Power, 87: 125-47(Apr. 1965).

This paper discusses the relative merits of various fuels for MHD power systems in which the MHD generator operates on combustion products and is coupled with a steam plant or gas turbine. The method of calculating the equilibrium gas composition is discussed, and results are given for alkali seeded product gas compositions and properties for cases of bituminous coal, coke, natural gas, residual oil, and alcohol. Electric conductivity, electron mobility, and attainable flame temperatures are evaluated. Fuels of low hydrogen content are shown to be advantageous, and it is shown to be desirable to introduce the alkali seed in a dry state. (auth)

23351 SOME EXPERIMENTS ON MITSUBISHI MHD GENERATOR DRIVEN BY A PLASMA JET. Toshio Ito and Tetsuya Morikawa (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rept., 6: No. 1, 75-92(Jan. 1965).

With an experimental MHD generator driven by an air plasma jet, electrical outputs as high as 15 kw were achieved. The thermodynamical and aerodynamical properties of the high-temperature working fluid were precisely determined, and the electrical characteristics were measured and theoretically examined. It was shown that the experimental results obtained through the measurements on the flow properties at both ends of the duct yielded good agreement with the theoretical values, which were indirectly predicted from the energy balance and the conservation of mass. But the electrical characteristics measured in the experiments differed from those which were predicted from the one-dimensional theory. However, the discrepancy between them was successfully explained by taking account of the temperature boundary layers developed over the low-temperature electrodes. (NSA of Japan)

23352 ALTERNATING-CURRENT POWER GENERATION WITH TRANSVERSE-CURRENT MAGNETOHYDRODYNAMIC CONDUCTION MACHINES. H. H. Woodson (Massachusetts Inst. of Tech., Cambridge). New York, Inst. of Electrical and Electronics Engineers, 1964, Preprint Paper 31 TP 65-32, 13p, $1.00. (CONF-650106-1)

From Institute of Electrical and Electronic Engineers, Winter Power Meeting, New York.

A new concept of MHD a-c power generation is discussed in which self-excited, transverse-current, MHD conduction generators are magnetically cross-coupled in such a manner that they operate as a balanced polyphase a-c power generator. The system is first analyzed assuming that the working fluid has a constant, scalar conductivity in a generator with continuous electrodes; and then the effects of tensor conductivity is considered in a generator having segmented electrodes. The analysis is based on an incompressible fluid model. The principal conclusions drawn from the theoretical study are presented. (L.B.S.)

23353 THE POTENTIAL AND CURRENT STATUS OF LIQUID METAL MAGNETOHYDRODYNAMICS. Michael Petrick (Argonne National Lab., Ill.). New York, Institute of Electrical and Electronics Engineers, 1964, Preprint Paper No. 31 CP 65-176, 20p, $1.00. (CONF-650105-5)

From Institute of Electrical and Electronic Engineers, Winter Power Meeting, New York.

The potential of the liquid metal MHD power cycle was found to be excellent. Overall cycle efficiencies of a binary cycle approaching 60% may be feasible. The liquid metal MHD cycle appears to be superior to the plasma cycle from several technical and economic viewpoints. There are, however, several major areas of uncertainties pertaining to the liquid metal MHD concept that can only be resolved through experimentation. Upon completion of current experimental programs, sufficient information and data should then be available to make a more thorough analysis of the true potential of the liquid metal MHD concept and to demonstrate the economic incentive for its development. (auth)

23354 FISSION FRAGMENT ENERGY SPECTRUM EFFECTS IN FISSION-ELECTRIC CELL EFFICIENCY CALCULATIONS. G. H. Miley (Univ. of Illinois, Urbana). 7p. (CONF-654-63)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The efficiency of a fission-electric cell was calculated, using a semi-empirical model for the fragment energy losses in the fuel layer. The model was fitted to spectrum measurements, and the effective charge of the fragments was assumed to be proportional to the velocity. Calculations for equal fitting parameters and for a monoenergetic source assuming various energy-charge loss models were compared. For a given model, integration over the fission spectrum reduces the efficiency by as much as 20%. A strong dependence on the energy-charge model selected was also observed. (D.C.W.)

Elementary Particles and Radiations

Refer also to abstracts 22862, 23338, 23499, 23757, and 23758.

23355 (BNL-867(p.1-117)) PHYSICAL SCIENCES AND ENGINEERING. (Brookhaven National Lab., Upton, N. Y.).

Experiments based on the reaction $p + p \rightarrow d + \pi^+$ were conducted at the Cosmotron. Other research at the Cosmotron included studies of multipion resonances, charge exchange in $\pi^- + p \rightarrow \pi^0$ and η_0 production in $\pi^- + p \rightarrow \eta + p$, K^0 decay, production of monoenergetic neutrons, beta decay of hyperons, K_e^3 decay, K_μ^3 decay, and the Σ-n system bound state. Alternating Gradient Synchrotron (AGS) work is reported on K^0 decay and production and decay of the Ω^-. Other AGS research on elastic scattering at ≈ 25 Bev of mesons, protons, and antiprotons on H_2 is reported along with measurements at high energies of p-p elastic scattering and results of an experiment in which two new π-N resonances were discovered. A meson temporarily designated X^0 was added to the list of resonances. Observation of resonances between pions and multipions is reported. Observation of the Ξ^0 is also reported. The mass and lifetime of the Ξ were measured, and conversion of K_2^0 into K_1^0 was observed. Decays of the K^0 were studied, the masses and lifetimes of the ω and φ were determined. Work of the theoretical group was concerned mainly with specific and general aspects of particle physics are described. Operation of the 80-in. bubble chamber is described along with efforts devoted to data analysis. Efforts devoted to the design of new particle physics research facilities, instruments, and data handling methods are discussed. Nuclear structure research is reported on properties of energy levels, characteristics of transitions, and parameters of nuclear reactions. Research is also reported on neutron physics, atomic and molecular physics, and solid state physics. Operations of the Cosmotron and the AGS are described along with accelerator development and accelerator component fabrication. Advances in computer applications and data handling systems are discussed along with semiconductor detector and circuit development. Research in chemistry was concerned with nuclear reactions and spectroscopy, geo- and cosmochemistry, activation analysis, radiation chemistry, molecular and crystal structure, chemistry of isotopes, inorganic solution chemistry, and ion-molecule reactions. Engineering research is reported on reactor physics, metallurgy, chemistry and chemical technology, and hot laboratories. Efforts in applied mathematics were devoted to the central computing facility and mathematics research. Supporting activities are summarized. (J.R.D.)

23356 (IC/65/13) THE LINEAR REPRESENTATIONS OF $\tilde{SU}_3$. Christian Fronsdal (International Centre for Theoretical Physics, Trieste (Italy)). 1965. 26p. Dep. (mn).

The representations of a noncompact form $\tilde{SU}_3$ of SU_3

were studied, with emphasis on the unitary ones. Some of the representations, though infinite-dimensional, appear to be suitable for describing elementary particle multiplets. For baryons the only new particle of strangeness larger than −3 that is predicted is with strangeness −2 and isotopic spin $^3/_2$. The most important companion to the "decuplet" resonance is a Y_2^*. It seems likely that many theoretical predictions of SU_3 are carried over to $\widetilde{SU}_3$. (auth)

23357 (JINR-D-1926) CP VIOLATION AND INTERFERENCE PHENOMENA IN DECAY OF NEUTRAL K MESONS INTO TWO PIONS. V. L. Lyuboshits, E. O. Okonov, M. I. Podgoretskii, and Tsun-fan Wu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1965. 18p. Dep.(mn).

The interference effects in the $K^0 \to \pi^+\pi^-$ decays are considered in the case of CP−invariance violation. It is shown that these effects are very pronounced under certain conditions. Their study makes it possible to solve the problem concerning the existence of the $K_2^0 \to \pi^+ + \pi^-$ decay. The "beating" in the $\pi^+\pi^-$ system has been considered for the K^0 and $\overline{K}^0$ meson beam as well as for the case of the interference of the $K_2^0 \to \pi^+ + \pi^-$ decay with that of K_1^0 mesons arising as a result of regeneration from the plate. (auth)

23358 (JINR-P-1900) O VOZMOZHNYKH IMITATSIYAKH RASPADA $K_2^0 \to \pi^+ + \pi^-$. (On Possible Simulating Process of the $K_2^0 \to \pi^+\pi^-$ Decay). E. O. Okonov and Tsung-Fan (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1964. 11p. Dep.(mn).

Possible processes that could simulate the $K_2^0 \to \pi^+\pi^-$ decay have been analyzed. As such a process there could be, under certain conditions, the electromagnetic decay $x^0 \to e^+e^-$ where x^0 is the hypothetical long-lived particle (M = 412 Mev, S = 0, $J^{PC}0^{+-}$). It is shown that it is possible to finally prove the existence of the $K_2^0 \to \pi^+\pi^-$ decay (to exclude the $K_2^0 \to \pi^-\pi^-\gamma$ decay accompanied by the emission of the low-energy photon) if the interference phenomena are observed in the $K_2^0 \to \pi^+\pi^-$ system which has a pronounced character at large enough t. (auth)

23359 (JINR-P-1965) METOD RESHENIYA URAVNENII TIPA URAVNENII CHU-LOU. (A Method for Solving Equations of Chew-Low Type). V. A. Meshcheryakov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 9p. Dep.(mn).

A method is proposed for solving equations of Chew-Low type which describe the scattering of particles with l_1 by a source with spin l_2. The method is based on conformal mapping. As an example, a solution for $l_1 = l_2 = 1$ is given. (auth)

23360 (JINR-P-1982) PROGRAMMA IDENTIFIKATSII RASPADA V^0-CHASTITS (Programma 2-3). (A Programme for Identification of V^0 Decay (Programme 2-3)). A. F. Luk'yantsev, V. I. Moroz, V. I. Nikitina and B. A. Shakhbazyan (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1964. 34p. Dep.(mn).

A "2-3" program for identification of Λ^0 and K^0 particles whose decays are detected in a bubble chamber is described. This program is as follows: the direction of the V^0 flight is chosen by the functional; the coplanarity of the V^0 event is included into the total functional; the program incorporates a logic that decreases automatically the number of constraint equations if one of the momenta of the decay products cannot be measured; and in minimizing the functional the constraint equations are included into it. These equations have the form of an additional quadratic term with a weight T whose effect is eliminated at the last step by the method of indefinite Lagrange factors. The starting material of the program is located on the punched cards given by the programs 1-2, 1-15, 1-3 etc. Later the information is fed into the program from the magnetic tape. (auth)

23361 (JINR-P-1991) GRUPPA SIMMETRII SL(6) I RELYATIVISTSKOE OBOBSHCHENIE GRUPPY SIMMETRII SU(6). II. (Symmetry Group SL(6) and Relativistic Generalization of SU(6). [Part] II). Nguyen Van-hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 14p. Dep.(mn).

The wave equations are treated for the third and second rank spinors of the SL(6) group. A method of studying the broken SL(6) symmetry is discussed. (auth)

23362 (JINR-P-1993) NEKOTORYE EFFEKTY ISEVDOSKALYARNOGO MEZONA S NULEVOI MASSOI. (Some Effects of a Pseudoscalar Meson of Zero Mass). Doan-Nhuong (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 10p. Dep.(mn).

Some effects of the ξ meson of zero mass are considered: the scattering of ξ meson on electron (and on proton); the "photoeffect" of the ξ meson; and the production of positron-electron pairs in the nucleus field. The effects may be useful for detecting this hypothetic radiation. (auth)

23363 (NP-14954) ANNUAL PROGRESS REPORT FOR 1964. (Bartol Research Foundation, Swarthmore, Pa.). Mar. 11, 1965. Contract Nonr-3777(00). 22p.

Efforts devoted to determination of the absolute probability of the 6.880-Mev transition in ^{28}Si are described. Other work is reported on the properties of the 4.403- and 4.504-Mev excited states of ^{27}Al and on the properties of the 7.5-Mev state in ^{31}P. Measurements of the linear polarization of the resonance radiation from the 2.21-Mev level in ^{27}Al are reported. Results of studies of excited levels of ^{23}Na and ^{27}Al are included. Studies of electromagnetic properties of isobaric analog states were completed. Discussions are presented concerning the analog states in ^{90}Zr. The form factors describing the excitation of analog states by inelastic electron scattering were calculated. Measurements of cosmic ray intensity during flights and around-world cruises are reported. Isochasms for mid-latitude regions are discussed along with the cosmic ray equator and north-south plateau intensities. Measurements were also made of the attenuation length of the atmospheric nucleonic component and nucleon propagation through the atmosphere. Results of neutron multiplicity experiments are discussed. (J.R.D.)

23364 (NYO-3399-07) THE DYNAMICAL ORIGIN OF SYMMETRY OF ELEMENTARY PARTICLES. E. C. G. Sudarshan (Syracuse Univ., N. Y. Dept. of Physics). [1964]. Contract [AT(30-1)-3399]. 23p. (CONF-641115-1). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Physical Society Symposium on Symmetry in Particle Physics, Chicago.

The multiplet structure of elementary particles is discussed. An attempt is made to establish a dynamical origin of symmetries by starting from the existence of (mass-spin-parity degenerate) multiplets of interacting particles and requiring selfconsistency. The Smushkevich equations are deduced from field theory and from self-consistent dynamics. Unitary symmetry, octet-octet-octet coupling, SU_6, and broken symmetry are discussed. (C.E.S.)

23365 (NYO-3399-17) QUESTION OF COMBINING INTERNAL SYMMETRIES AND THE LORENTZ GROUP. E. C. G. Sudarshan (Syracuse Univ., N. Y. Dept. of Physics). [1964]. Contract [AT(30-1)-3399]. 14p. (CONF-650105-3). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From Conference on Symmetry Principles at High Energy, Coral Gables, Fla.

A discussion is given of group theory, relativistic spin-dependent symmetry groups, current structure and particle multiplets, McGlinn's theorem, and mathematical structure of symmetry algebras. (C.E.S.)

23366 ON THE PROPER MODES OF PROPAGATION OF X-RAYS. Edward J. Saccocio and Alfred Zajac (Polytechnic Inst. of Brooklyn). Acta Cryst., 18: 478-80 (Mar. 10, 1965).

The modes of propagation of an x-ray wave field for single diffraction were evaluated at the Bragg angle as an illustration of a method that can be applied to simultaneous diffraction. (auth)

23367 PARTICLE SYMMETRIES AND SPACE TIME CURVATURE. Yuval Ne'eman (California Inst. of Tech., Pasadena) and Joe Rosen. Ann. Phys. (N. Y.), 31: 391-409(Feb. 24, 1965).

Formal and physical aspects of providing particle internal symmetries with a space-time origin are studied. Quantum mechanics imposed a requirement of added dimensionality. A formalism introduced by Fronsdal and Joseph, postulating the abstracted existence of a pseudo-Euclidean space in which curved space-time is embedded, is developed. The global embedding space is used, without requiring it to be homogeneous or isotropic. Symmetries correspond to available transformations carrying the Riemann space—or part of it—into itself; the Lorentz group does it locally, operating in the Minkowski tangent space. In addition, the Joseph generators corresponding to orthogonal transformations in the normal space are employed. Known local solutions of the Einstein equations and recent developments in differential geometry are used to find that local embeddings require ten dimensions, with a possibly compact normal subspace. Global embeddings may require more dimensions, though this is not corroborated by the experience gained from embedding the present set of cosmological models. The probable total endosymmetry can be fitted in a ten-dimensional embedder provided analytical continuation in the Joseph space is applied. If only real rotation groups are considered, both plausible chiral schemes require sixteen dimensions in the embedding. The main physical consequence for particle interactions, according to the geometrical model of symmetry breaking suggested, would reside in predicting symmetry breakdown in regions of very high curvature, such as may be found in some stellar cores. (auth)

23368 THE QUANTUM NUMBERS OF THE NUCLEON ISOBARS. A. Donnachie and J. Hamilton (University Coll., London). Ann. Phys. (N. Y.), 31: 410-35(Feb. 24, 1965).

It is shown that the quantum numbers of the 200, 600, 900 Mev, and 1.35 Bev nucleon isobars are determined by the systematic properties of the longer range parts of the pion-nucleon interactions. This makes it possible to understand the Regge plot in terms of the interactions which produce the several families of isobars. A relation between the impact parameter and the slope of the plot is given, and some conjectures are made concerning possible higher resonances. The special case of the nucleon and the role of elasticity in producing resonances are also discussed. (auth)

23369 FIXED ANGLE DISPERSION RELATIONS FOR THE LOW-ENERGY PHOTOPRODUCTION OF PIONS ON NUCLEONS. PART I. THEORY WITHOUT PION-PION INTERACTION. G. Bialkowski (Univ. of Warsaw) and A. Jurewicz. Ann. Phys. (N. Y.), 31: 436-68(Feb. 24, 1965).

The dispersion approach to the low-energy photoproduction of pions on nucleons is reexamined in such a way as to avoid the contributions coming from the unphysical cosine region. Analytic representations for invariant amplitudes in the squared cms three-momentum plane are managed so as to get rid of all but the dynamical singularities. First, only contributions from the direct and crossed photoproduction channels are retained, and relativistic dispersion relations for multipoles are deduced by integration over the scattering angle. By making use of the unitarity condition in the two-intermediate-particle approximation and considering the pion-nucleon phase shifts as quantities known from experiment, it is easy to transform the dispersion relations into a set of integral equations to be solved numerically. (auth)

23370 U-SPIN AND THE MASS SPLITTING OF UNITARY MULTIPLETS. G. Feldman (Johns Hopkins Univ., Baltimore) and P. T. Matthews. Ann. Phys. (N. Y.), 31: 469-80(Feb. 24, 1965).

The relations between the masses in a unitary multiplet are derived from the U- and I-spin properties of the mass splitting interactions. Various simple rules—the parallelogram law and the nth difference rule—are derived. It is shown that the Gell-Mann-Okubo formula is just an equal spacing rule for particles within a U-multiplet. (auth)

23371 MOTION OF RESONANCE POLES WITH ANGULAR MOMENTUM IN S-MATRIX THEORY AND RELATED TOPICS. C. Edward Jones (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 31: 481-505(Feb. 24, 1965).

A general discussion is carried out of resonance poles in multi-two-body channel S-matrix theory. After Regge, the poles are defined by surfaces in energy-angular-momentum space. The inverse of the Regge trajectory $\alpha(\nu)$ is used to study the poles in the energy plane arising from a given Regge trajectory and the motion of the poles near threshold with angular momentum. These pole motions have implications similar to conclusions recently derived on the basis of a picture in which the coupling strength is varied. One of the results is a unified understanding of the behavior of poles near threshold for the s-wave case and the corresponding behavior for poles of higher angular momentum. The function $\alpha(\nu)$ is found to possess all information needed to describe the resonance including a specification of associated energy poles on a number of Riemann sheets. A number of related questions are also considered: the general question of defining a resonance pole in the many-channel problem; the precise formulation of those conditions under which a resonance pole is near enough to the physical region to produce an observable peak; the meaning of a resonance near threshold; the possibility of diagonalizing the S-matrix for nonintegral angular momenta and unphysical energies; properties of $\alpha(\nu)$ for the many-channel problem including the positive definiteness of Im α; the possibility of Regge trajectories decoupling from certain channels and the relation of this possibility to conservation laws and their derivation. The discussion is very general, using only unitarity and plausible assumptions about the analyticity of scattering amplitudes in angular momentum and energy. (auth)

23372 THRESHOLD AND ASYMPTOTIC BEHAVIOR OF THE N/D EQUATIONS. Myron Bander and Gordon L. Shaw (Stanford Univ., Calif.). Ann. Phys. (N. Y.), 31: 506-24 (Feb. 24, 1965).

Two important problems involved in obtaining solutions of partial-wave dispersion relations by the N/D method are having (i) the correct threshold behavior and (ii) an acceptable high energy behavior. The sensitivity of the solutions of the N/D equations to approximations insuring (i) and (ii) is numerically investigated. $J = 1$ π-π scattering is considered, employing elastic unitarity and assuming that the left hand cut is dominated by the exchange of the ρ resonance. It is found that the values of the cutoffs needed to produce a resonance are quite sensitive to the input strength of the left hand cut, e.g., a change of the input width of the ρ by a factor of two changes the value for a straight cutoff to produce a resonance at a given energy by a factor of ten. Because of this the possible danger in employing a single cutoff in the calculations of SU_3 multiplets is emphasized. It is also found that if a pole is introduced on the left hand cut in order to insure the threshold behavior (i), then the ranges in values for the cutoffs to insure (ii) for which any resonance occurs are extremely narrow. On the other hand, a solution in which the phase shift does not become large is insensitive to the position of this pole. (auth)

23373 RELATIVISTIC TWO-PARTICLE SCATTERING. [PART] I. L. B. Redei (Umeå Univ., Sweden). Arkiv Fysik, 29: 1-9(1965).

A relativistic scattering model is constructed within the approximation that the two-particle scattering system is closed, i.e., that inelastic and production processes can be neglected. The model is sufficiently general to produce a given set of phase shifts $\delta_l(M)$ provided $\delta_l(M) \to 0$ (mode π) for large M sufficiently fast and provided they follow one of the four physically interesting patterns of behavior. (auth)

23374 RELATIVISTIC TWO-PARTICLE SCATTERING. [PART] II. L. B. Redei [(Umeå Univ., Sweden).] Arkiv Fysik, 29: 11-21[1965).

A relativistic model for two spinless particles is investigated which gives no indication of the phase shift tending to an integral of π. The model reproduces this

phase shift and satisfies the asymptotic conditions. The interacting generators of the inhomogeneous Lorentz group are well defined self-adjoint operators. The domains of the interacting hamiltonian and the asymptotic hamiltonian are compared. (L.B.S.)

23375 ATOMIC NUCLEI AND ELEMENTARY PARTICLES. G. Eder. Atomkernenergie, 10: 47-50(Jan.-Feb. 1965). (In German)

The systematics of atomic nuclei, elementary particles, and their excited states is presented with respect to their quantum numbers, their lifetimes, and their decay schemes. The corresponding states of nuclei and elementary particles are compared with each other. (auth)

23376 A NOTE ON A SOLUBLE THREE-BODY PROBLEM. L. M. Delves (Univ. of New South Wales, Kensington, Australia). Australian J. Phys., 18: 101-7(Apr. 1965).

A class of soluble three-body systems suggested by Pluvinage is studied. The Hamiltonian H_0 of these systems is not Hermitian, and the energy spectrum contains a continuum of bound states. The use of H_0 as a reference Hamiltonian in calculations of the helium atom ground state, as suggested by Pluvinage and Walsh, is discussed in the light of these results. (auth)

23377 INTERACTIONS IN THE FINAL STATE AND INTERFERENCE OF AMPLITUDES IN AN ANNIHILATION PROCESS FOR PROTONIUM. J. Vandermeulen (Universite, Liege). Bull. Soc. Roy. Sci. Liege, 33: 787-800(1964). (In French)

A phenomenological model is outlined for interpreting the experimental observations on the annihilation at rest $p + \bar{p} \rightarrow 2K_1^0 + \pi^+ + \pi^-$. The existence of the resonances is treated by the introduction of final-state interactions. (D.C.W.)

23378 GROUP THEORETICAL STUDY OF LEPTONIC PROCESSES. James McConnell (Universite, Laval, Quebec). Can. J. Phys., 43: 705-15(Apr. 1965).

The leptons are classified according to the B_2 group, and it is shown how conservation laws for leptonic processes are related to invariances of the interaction Lagrangian density under the group transformations. (auth)

23379 ON THE CONDITIONS FOR THE OCCURRENCE OF VAVILOV-CHERENKOV AND TRANSIENT RADIATION. J. Cirak (Slovak Technical Univ., Bratislava). Czech. J. Phys., 15: 225-35(1965). (In Russian)

Attention is drawn to the connection between the virtual parameters and the physical effects produced during the rapid motion of a charged particle in a mass medium. In particular, the virtual position of a particle and its virtual velocity as a function of the real velocity of the particle and the position of the observer are investigated. On the basis of such a study it was possible to formulate a new method for the interpretation of the basic properties of Vavilov-Cherenkov and transient radiation. This method can be used in a simple manner to determine the conditions for the occurrence and the directional characteristics of Vavilov-Cherenkov radiation in both a homogeneous and an inhomogeneous medium. A study of the virtual parameters of a particle on the interface between two optics of different media leads to the assumption of the existence of two kinds of transient radiation. (auth)

23380 A THEORETICAL AND EXPERIMENTAL STUDY OF THE RADIATION FIELD OF A HOMOGENEOUS, SELF-ABSORBING SPHERICAL RADIOACTIVE SOURCE. Y. Bresson, A. H. Morris, B. Herszberg, and C. Kellershohn (Faculte de Medecine, Paris). Intern. J. Appl. Radiation Isotopes, 16: 243-56(Apr. 1965). (In French)

Following a restatement of the definitions of those dimensions by which a γ radiation field may be quantitatively specified, the general case is considered of a spherical radioactive source which is homogeneous and self-absorbing, having a total linear absorption coefficient μ, surrounded by a non-radioactive shell of absorbent medium having a total linear absorption coefficient μ'. Allowance being made for the total absorption (attenuation) but not for diffusion, two expressions are given which define the radiation field at a point P outside the shell, in terms of energy flux density, spherical intensity, and energy illumination, or plane intensity. Corresponding expressions are likewise given for the following particular cases: for P inside the shell with $\mu' \neq \mu$, $\mu' = \mu$, $\mu' = 0$, $\mu' = \mu = 0$, and for P inside the radioactive sphere. These latter expressions, some of which are given as functions of elementary algorithms or of known tabulated functions, are discussed, as also are their implications. An account is given of an experimental study, the results satisfactorily confirming the validity of the expressions put forward. (auth)

23381 REAL PART OF THE AMPLITUDE OF THE ELASTIC K^+-p DISPERSION IN HIGH-ENERGIES. Ch. Palev. Izv. Fiz. Inst. Aneb, Bulgar. Akad. Nauk, 12: 137-41(1964). (In Russian)

The behavior of the real part of the elastic scattering amplitude is examined. It is presumed that total cross section of scattering for high energies has a tendency toward a constant value and can be decomposed in the order of diminishing energy grades. The non-diffraction cross section of scattering decreases as the square of energy. It is shown that for energies greater than 100 Bev, the real part of the scattering amplitude is constant and equal to 1.9×10^{-13} cm. (auth)

23382 HIGHER-ORDER STATIONARY-PHASE APPROXIMATIONS IN SEMICLASSICAL SCATTERING. Francis J. Smith, E. A. Mason, and J. T. Vanderslice (Univ. of Maryland, College Park). J. Chem. Phys., 42: 3257-64(May 1, 1965).

Higher-order stationary-phase approximations were used to calculate corrections to the classical expression for the differential cross section for elastic scattering. An expansion for the cross section as a series in $\hbar^2$ was obtained, whose first term is the classical result. An oscillating term is also present, whose "wavelength" is approximately $\Delta\theta \approx 2\pi/kb$. Both the wavelength and the amplitude of this term vary as $\hbar$. It is shown that the classical differential cross section is valid for angles as small as the critical angle defined by Massey and Mohr. A similar technique was used to obtain corrections to Ford and Wheeler's semiclassical expression for the differential cross section at a rainbow angle. An expansion as a series in $\hbar^{\frac{2}{3}}$ was derived, whose first term varies as $\hbar^{-\frac{1}{3}}$ and hence diverges in the classical limit. It is shown that the leading term agrees with Ford and Wheeler's result and that the first correction term is very small for a 12–6 potential. (auth)

23383 SYSTEMATICS OF PARTICLES—ROTATION LEVELS AND HYPER MULTIPLET. Seitaro Nakamura (Tokyo Univ. and Nihon Univ., Tokyo). J. Phys. Soc. Japan, 20: 187-9(Feb. 1965).

By introducing an internal orbital L, the mass spectra of the nucleon family are accommodated into two groups, each having opposite internal parity from the other and each manifesting the rotation-spectrum character $M^2 = L(L+1)a^2 + M_0^2$, where α and M_0 are constants. For each of the L-values, the hypermultiplets characterized by the values of the hypercharge Y(Y = 0, ±1, ±2) are introduced and compared with the experiments. (auth)

23384 THE MESON-NUCLEON PHENOMENA AND THE MANY BODY PROBLEM. Chiaki Ihara. Mem. Fac. Eng., Kyoto Univ., 26: 28-33(Jan. 1964).

The dynamical theory of the many body problem is used to account for the meson-meson resonance and to investigate the behavior of the nucleon pair from the standpoint of a composite model of pion. (auth)

23385 ON A POSSIBILITY FOR MEASUREMENT OF THE EFFECTIVE MASS (REST MASS) OF ELECTRONS. Karl Nowak. Neue Physik, 4: 73-6(1964). (In German)

If the charge carrier path of an electron is not linear relative to the spiral path of the "matter pulse," there may be significant deviations in the results obtained by the usual method of measurement of the rest mass of the electron. If, instead of an effective velocity of the charge carrier v, only an apparent movement velocity v_s is used for the progression velocity in the spiral path, it is no longer

possible to determine effectively the particle mass by measurement of the deviation in an electric or magnetic field. Only an apparent mass value, but not the effective rest mass can be determined. The author suggests a measurement arrangement where the electron is accelerated entirely mechanically at a known velocity in order to measure the effective mass on the basis of the mechanical energy developed. When the emission source is moved relative to the recording device the linear charge carrier velocity is superimposed on the spiral path-propagation velocity of the charge carrier. The device consists of a high vacuum chamber, containing an electron beam source of slow electrons of ~1000 ev, mounted on a disk that can be rotated at accurately defined, but variable velocities. The electron beam can be directed to a mass spectrograph. Comparison of the electron beam characteristics can be made by varying the rotational speed of the spiral, and the rest mass of the electrons can be calculated by the mathematical formulations briefly outlined. (BBB)

23386 MOTION OF POLES OF THE QUANTAL PARTIAL-WAVE AMPLITUDE IN THE COMPLEX PLANE OF THE COUPLING CONSTANT. Yu. M. Lomsadze, I. V. Khimich, and J. M. Shuba (State Univ. of Uzhgorod, Ukrainian SSR). Nucl. Phys., 67: 631-40(June 1965).

Analytical properties of the quantal partial-wave amplitude $f_g(l,k)$ in the complex plane of the coupling constant g are investigated for a wide class of potentials satisfying standard physical conditions. A bounded region $\Omega(l,k>0)$ of holomorphy for $f_g(l,k)$ in the g plane is shown to exist involving the points $g = 0$ and $g = g^{obs}$ for any observable value g^{obs} of the coupling constant. This makes it possible to apply the Mittag-Leffler method to the effective calculation of $f_g^{obs}(l,k)$ (and hence the total amplitude $T_g^{obs}(l,k)$ for an arbitrary value of g^{obs}, with any desired degree of accuracy, on the basis of the information contained in the coefficients of a finite number of the perturbation series for $f_g(l,k)$. (auth)

23387 SCALAR VARIABLES FOR THE S MATRIX IN STRONG INTERACTIONS. F. Rohrlich (Syracuse Univ., N. Y.). Nucl. Phys., 67: 659-65(June 1965).

A method is presented by which $3n-9$ scalar variables can be selected in a systematic way for the complete kinematical description of processes with n participating particles (n external lines) of non-vanishing mass. One relation between these variables exists and limits them to $3n-10$ independent scalar variables appropriate to the number of degrees of freedom. For $n = 4$ they are equivalent to the Mandelstam variables s, t, and u. The additional information required to determine the momenta on the basis of the scalar variables and the masses is also specified. (auth)

23388 ASYMPTOTIC RELATIONS BETWEEN THE AMPLITUDES OF PRODUCTION PROCESSES. A. A. Logunov, Nguyen Van Hieu, and I. T. Todorov (Joint Inst. for Nuclear Research., Dubna, USSR). Nucl. Phys., 67: 666-72(June 1965).

A method for obtaining asymptotic relations between the amplitudes of production processes in local field theory is given. This pair of processes $\pi + N \rightarrow \pi' + \pi'' + N'$ and $\bar{\pi} + N' \rightarrow \bar{\pi}' + \bar{\pi}'' + N$ is considered in detail, and asymptotic equality between their differential cross sections is proved. (auth)

23389 MANY-PARTICLE GREEN FUNCTIONS IN THE VECTOR MESON THEORIES. G. Pocsik (Roland Eotvos Univ., Budapest). Nucl. Phys., 67: 673-78(June 1965).

Non-renormalizable interactions of massive vector mesons are examined without making use of perturbation expansions in the coupling constant. By discussing the characteristic example of the pseudovector meson-fermion coupling, it is shown that in the many-body Green functions exponentially divergent expressions occur. These exponential singularities can partially be removed from Green functions by choosing suitable canonical variables. The whole theory is, however, undefined in its original form. A possibility for defining Green functions is the analytic continuation with respect to the square of the coupling constant. (auth)

23390 PHOTOPRODUCTION OF π^0 MESONS ON DEUTERIUM IN THE NEAR-THRESHOLD ENERGY REGION. A. S. Belousov, A. I. Lebedev, S. V. Rusakov, E. I. Tamm, and A. S. Tatarinskaya (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 67: 679-93(June 1965).

Results of an experimental study of the photoproduction of π^0 mesons on deuterium for near-threshold γ quantum energies are discussed in terms of phenomenological theory. The overall differential cross section for elastic and inelastic photoproduction is shown to be in agreement with impulse approximation predictions only for meson emission angles $\theta_\pi < 90°$ for which the elastic process predominates. For angles $\theta_\pi > 90°$ there are discrepancies between experimental data and theoretical predictions which cannot be attributed to the contribution of multiple scattering effects. (auth)

23391 MANY-PARTICLE REACTION AMPLITUDE AND POLE REACTIONS. V. M. Kolybasov (Inst. of Theoretical and Experimental Physics, Moscow). Nucl. Phys., 68: 8-16(June 1965).

The many-particle interaction amplitude is expressed in the nonrelativistic case through invariant form factors for arbitrary spins of the particles involved in the interaction. This expression is then used to investigate the pole reaction. (auth)

23392 AN EFFECTIVE RANGE FORMULA FOR A POTENTIAL WITH A HARD CORE. M. W. Kermode (Univ. of Liverpool). Nucl. Phys., 68: 93-6(June 1965).

An effective range formula for a potential which is of the form of a hard core surrounded by an attractive well, together with a Coulomb repulsive field, is derived. The formula is applied to the S-wave phase shifts for the elastic scattering of alpha particles from helium. A good agreement with experiment is obtained for a hard core radius of 1.5 fm. (auth)

23393 LEPTONIC DECAYS IN SU(6) SYMMETRY AND THE $\Omega^- \rightarrow \Xi^0 + e^- + \nu$ BRANCHING RATIO. I. J. Muzinich (Univ. of Washington, Seattle). Phys. Letters, 14: 252-3 (Feb. 1, 1965).

The weak interaction hamiltonian for leptonic decays is obtained, assuming the Cabibbo form of the weak interaction current and that it transforms like the 35 representation of SU(6) symmetry. The matrix elements of the currents and the branching ratios are tabulated. (L.B.S.)

23394 STATISTICS OF PARTICLES AND ANTIPARTICLES AT HIGH TEMPERATURES. A. Wataghin (Universita, Genoa and Istituto Nazionale di Fisica Nucleare, Genoa). Phys. Letters, 15: 308-10(Apr. 15, 1965).

An attempt is made to establish asymptotic formulas concerning the equilibrium state of elementary particles and antiparticles at high temperatures. The particles considered are all the fermions and bosons with mass not above the mass of the meson (K). It is supposed that the equilibrium conditions are such that the independent particle model is applicable. (C.E.S.)

23395 SOME RELATIONS ON THE SCATTERING OF PSEUDOSCALAR MESONS OFF BARYONS IMPLIED BY A RELATIVISTIC SU(6) SYMMETRY MODEL. W. Ruehl (CERN, Geneva). Phys. Letters, 15: 340-1(Apr. 15, 1965).

The S matrix element for scattering of pseudoscalar mesons on spin-$\frac{1}{2}$ baryons (the mesons belong to the 35-dimensional representation of SU(6), the baryons fill the octet of the representation 56) is discussed. It is concluded that the $f(K^+) - f(K^-) = f(\pi^+) + f(K^0) - f(\bar{K}^0)$ and $f(\pi^-p \rightarrow K^+\Sigma^-) = f(K^-p \rightarrow \pi^+\Sigma^-)$ are a consequence of the relativistic SU(6) symmetry model, whereas $f(\pi^+) - f(\pi^-) = f(K^0) - f(\bar{K}^0)$ is true under the additional assumption that irreducible couplings are negligible. (The f(x) means the scattering amplitude in the forward direction of a meson (x) on a proton, taken at a certain value of the center of mass energy.) (C.E.S.)

23396 PHENOMENOLOGICAL STUDY OF PROTON COMPTON SCATTERING AND PION-NUCLEON REACTIONS AT RESONANCE ENERGY. S. Minami (Osaka City Univ.). Phys. Letters, 15: 342-4(Apr. 15, 1965).

By means of an isobar model it is shown that the phase

shift (δ_{11}) of proton Compton scattering due to a resonant state N* is equal to zero at the excitation energy of the N*. An example is given by performing a phenomenological analysis of meson(π)–nucleon and photon–proton collisions at the second resonance. On the basis of the analysis, both $\sigma(\gamma + p \rightarrow 2\pi + N)$ and $\sigma(\gamma + p \rightarrow \gamma + p)$ at the resonance are estimated. It is pointed out that the phase shift (δ_{13}) of p-p scattering may be nearly equal to zero at the excitation energy of the D_{12} resonance. (C.E.S.)

23397 EXCHANGE MECHANISM FOR ω-PRODUCTION IN π^+-n INTERACTIONS. H. O. Cohn (Oak Ridge National Lab., Tenn.), W. M. Bugg, and G. T. Condo. Phys. Letters, 15: 344-6(Apr. 15, 1965).

An analysis of ~2800 events of the type $\pi^+ + d \rightarrow (p) + p + \pi^+ + \pi^- + \pi^0$ from 3.25-Bev/c mesons (π) incident on the deuterium bubble chamber is presented. The Chew-Low plots for the 3π and 2π events are shown. The narrow ω band at $m_\pi^2 = 0.6$ Bev is clearly resolved and shows that ω production is present at much higher momentum transfer (Δ^2) than is ρ production which has practically vanished at $\Delta^2 = 15\ m_\pi^2$. The plots also indicate the presence of the η and f^0 mesons as well as a 3π resonance in the mass region of the A_2 (1310). The one ρ exchange model for ω production is investigated. (C.E.S.)

23398 HIGHER MESON RESONANCES AND THE $\underline{4212}^+$ MULTIPLET OF $\bar{SU}(12)$. R. Delbourgo (International Centre for Theoretical Physics, Trieste, Italy). Phys. Letters, 15: 347-50(Apr. 15, 1965).

An attempt is made to fill the 4212^+ multiplet of $\bar{SU}(12)$ and to determine the implications of $\bar{SU}(12)$ symmetry on the various decay modes. A very similar representation to the $\underline{4212}^+$ is the $\underline{5940}^+$, but it is neglected for the sake of simplicity. The $\underline{4212}^+$ comprises, in addition to the $\underline{189}$ of $\bar{SU}(6)$, another $\underline{35} + \underline{1}$ states. Its physical content and assignments are discussed. (C.E.S.)

23399 ON THE HIGH ENERGY BEHAVIOUR OF THE REAL PART OF THE FORWARD SCATTERING AMPLITUDE. R. Wit (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 15: 350-1(Apr. 15, 1965).

Two questions related to the behavior of scattering amplitudes at high energies are discussed. The questions of how many subtractions must be made and how to take into account the high-energy contribution to the dispersion integrals are considered. (C.E.S.)

23400 PHYSICAL PROPERTIES OF QUARKS. P. G. O. Freund (Inst. for Advanced Study, Princeton, N. J.). Phys. Letters, 15: 352-3(Apr. 15, 1965).

It is assumed that quarks can exist as particles, and properties of these particles are discussed. The strength of the coupling of quarks to the 35 odd parity mesons is estimated. The quark magnetic moment is also derived. It is concluded that should quarks be observed as particles, these properties will provide an unambiguous test for intrinsically broken M(12) invariance of strong interactions. (C.E.S.)

23401 PARITY DETERMINATION IN PARTICLE PHYSICS. P. L. Csonka, M. J. Moravcsik, and M. D. Scadron (Univ. of California, Livermore). Phys. Letters, 15: 353-5(Apr. 15, 1965). (UCRL-12337-T)

An attempt is made to establish some general theorems about the type of experiments that can be used for the determination of the parity of one of the particles in a reaction. The results are relevant only to reactions based only on rotation and reflection invariance. (C.E.S.)

23402 INVESTIGATION OF THE REACTION $p\bar{p} \rightarrow N_3^3\bar{N}_3^3$ AT 5.7 Gev/c AND 3.6 Gev/c. K. Boeckmann (Universitat, Bonn and Kernforschungsanlage, Julich, Ger.), B. Nellen, E. Paul, et al. Phys. Letters, 15: 356-9 (Apr. 15, 1965).

A large fraction of the reaction $p\bar{p} \rightarrow p\bar{p}\pi^+\pi^-$ proceeds via the quasi two body channel $p + \bar{p} \rightarrow N_{33}^{3*} + \bar{N}_{33}^{3*}$, the production and subsequent decay of a $\frac{3}{2}, \frac{3}{2}$ isobar-antiisobar pair. Experimental results for the two body channel with the momentum of the incoming $\bar{p}$ of 5.7 Bev/c are presented. The differential cross section $d\sigma/d\Delta^2$ and the angular distribution as expressed by the spin density matrix elements $\rho_{mn}(\Delta^2)$ are given, Δ^2 being the square of the four-momentum transfer between the incident antiproton and the outgoing anti-isobar. The results are compared with a previous experiment at 3.6 Bev/c and with theoretical predictions of the peripheral model including form factors. (C.E.S.)

23403 PROTON-NEUTRON MAGNETIC MOMENT RATIO IN WIGNER'S THEORY OF SUPERMULTIPLETS. Y. C. Leung and A. O. Barut (International Atomic Energy Agency, Trieste, Italy). Phys. Letters, 15: 359-60(Apr. 15, 1965).

A re-examination of Wigner's theory of supermultiplets, which is denoted by its symmetry group SU_4, is proposed in view of recent results from considerations of the symmetry group SU_6. One of the major successes of the SU_6 theory is attributed to the correct prediction of the ratio of the proton to neutron magnetic moment. It is shown that this result can also be obtained from the SU_4 theory. (C.E.S.)

23404 POSITRON ANNIHILATION IN SOLID ARGON. K. L. Rose and S. DeBenedetti (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 138: A927-33(May 3, 1965).

The angular distribution of the radiation from two-quantum annihilation in polycrystalline argon was measured. The same distribution was computed theoretically in good quantitative agreement with experiment. The calculation is based on a modification of the method of Berko and Plaskett and ignores electron-positron correlation. Tightly bound electrons are assumed and a model for the positron wave function, based on a Wigner-Seitz calculation, is proposed. The main contribution to the momentum distribution arises from the overlap of the electron wave functions with the positron wave function inside the Wigner-Seitz sphere centered at the origin, but there is also a significant contribution from the overlap of the electron functions with the positron function in neighboring spheres. From the agreement obtained, one may conclude that the angular distribution due to annihilations with core electrons is understandable on the basis of this rather simple picture, and that such annihilations are responsible for the large-angle features typical of the angular distributions for solids in general. However, a calculation of the mean life based on the above model yields a result which overestimates the experimental value by a factor of about 6. (auth)

23405 LIMITS ON PARITY AND TIME-REVERSAL NONINVARIANCE IN p-p SCATTERING. E. H. Thorndike (Univ. of Rochester, N. Y.). Phys. Rev., 138: B586-96 (May 10, 1965). (UR-875-67)

A formalism for p-p elastic scattering is developed that includes the possibility of parity nonconservation and time-reversal noninvariance. Relevant experimentally measurable quantities are defined. An experiment measuring three of the quantities is described. These and other measurements relevant to parity nonconservation or time-reversal noninvariance are analyzed in terms of the formalism developed. No evidence is found for any violation of either invariance principle. The parity-conserving, time-reversal-noninvariant coupling of $^3P_2$ and $^3F_2$ states is at most 7% of its maximum possible value, in the energy range 140–210 Mev. The parity-nonconserving, time-reversal-invariant coupling of $^1S_0$ and $^3P_0$ states is at most 70% of its maximum possible value at 140 Mev. The parity-nonconserving, time-reversal-noninvariant coupling of $^1S_0$ and $^3P_0$ states is not bounded away from its maximum possible positive value, and is at most 60% of its extreme negative value at 140 Mev. The evidence against parity nonconservation is thus seen to be surprisingly weak. An experiment to sharpen the limits on parity nonconservation is suggested. (auth)

23406 D-STATE AND PICKUP EFFECTS IN NUCLEON-DEUTERON SCATTERING IN THE IMPULSE APPROXIMATION. H. Kottler and K. L. Kowalski (Case Inst. of Tech., Cleveland). Phys. Rev., 138: B619-26 (May 10, 1965).

The effects of the D state of the deuteron wave function and of the pickup scattering on elastic nucleon-deuteron scattering are investigated within the framework of the impulse approximation and with the neglect of the multiple

scattering. A detailed examination is made of the various terms which arise from the identity of the incident nucleon with the target nucleons, and of these only the so-called pickup term is retained in the calculation. The latter term is treated only in Born approximation; the validity of this approximation is discussed. The computations which are carried out at 40 and 150 Mev indicate that the effects of the D state and of the pickup scattering are quite large for scattering in the backward hemisphere. (auth)

23407 POSSIBLE ELECTROMAGNETICALLY INDUCED MUONIUM-ANTIMUONIUM CONVERSION. Michael J. Moravcsik and Richard Spitzer (Univ. of California, Livermore). Phys. Rev., 138: B655-64(May 10, 1965). (UCRL-12009-T)

The possibility of the existence of an electromagnetically induced transition between muonium and antimuonium is examined. An experiment is suggested involving the formation of muonium by the injection of positive muons into a helium-filled resonant cavity, which is excited at a frequency corresponding to the difference in interaction energy between muonium and helium, on the one hand, and that between antimuonium and helium, on the other. The sign of antimuonium formation is the observation of the fast electrons from μ^- decay. The dependence of the number of these on which of the various cavity modes is excited gives information on the relative intrinsic parity of muonium and antimuonium. If this turns out to be odd, then this measurement, when combined with the usual relation for the product of the intrinsic parities of a Dirac particle and its antiparticle, would determine the relative intrinsic parity of the muon and electron to be imaginary. The conservation of parity in electromagnetic phenomena and the absence of electromagnetic μ-e transitions would then both find their natural explanation in the single assumption that the observation of electromagnetic phenomena must be compatible with invariance under space inversion. (auth)

23408 REPRESENTATION MIXING FOR SU_3 AND G_2. N. Mukunda (Princeton Univ., N. J.), A. J. Macfarlane, and E. C. G. Sudarshan. Phys. Rev., 138: B665-6(May 10, 1965). (NYO-3399-04)

A theory whose exact invariance with respect to SU_3 is broken by interactions transforming like the hypercharge generator of SU_3 is studied in perturbation theory. Physical particle states corresponding to unperturbed SU_3 multiplets are obtained by mixing into these multiplets possible impurities corresponding to other SU_3 multiplets, these impurities being as general as the perturbation allows. The effect of symmetry breaking on various physical quantities like masses and magnetic moments can then be obtained in terms of mixing parameters, and interesting formulas follow various restrictions of their values. Similar considerations applied to G_2 show that many of the conclusions which made exact G_2 invariance unattractive remain for approximate G_2 invariance. (auth)

23409 STUDY OF A VECTOR-MESON BOOTSTRAP MODEL. R. E. Cutkosky and M. Leon (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 138: B667-70(May 10, 1965). (CAR-882-2)

Some self-consistent solutions of a simplified bootstrap model are studied. Self-consistency is imposed through properties of the Bethe-Salpeter equation. The method of solution and properties of the self-consistent sets of particles are described. (auth)

23410 PROTON-PROTON SCATTERING AT 1.48 Bev. A. M. Eisner, E. L. Hart, R. I. Louttit, and T. W. Morris (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 138: B670-7(May 10, 1965). (BNL-8706)

A sample of 2657 proton-proton scattering events at 1.48 Bev was analyzed. The elastic cross section is 19.86 mb, and the elastic scattering is consistent with a simple opaque-disk optical model with R = 0.91 F and 1-a = 0.864. The dominant feature of the inelastic scattering is the production of the $(\frac{3}{2}, \frac{3}{2})$ isobar. The reaction $p + p \rightarrow p + n + \pi^+$ is interpreted satisfactorily in terms of the one-pion-exchange model. (auth)

23411 VERY SHORT-RANGE INTERACTION IN PION-NUCLEON SCATTERING. A. Donnachie (London Univ.) and J. Hamilton. Phys. Rev., 138: B678-88(May 10, 1965).

The dispersion relations for $F_l(s) = f_l(s)/a^{2l}$, where $f_l(s)$ is the usual partial-wave amplitude, are required by unitarity to obey a high-energy boundary condition. It is shown that this gives rise to a unitary sum rule. This sum rule can be used to estimate the short-range parts of the pion-nucleon interaction, and that makes it possible to give accurate predictions of the nonresonant P-, D-, and F-wave π-N amplitudes up to around 650 Mev. The results are in good agreement with a recent analysis of the experimental data. (auth)

23412 MASS SPLITTINGS WITHIN SPIN-DEGENERATE MULTIPLETS. M. Y. Han (Syracuse Univ., N. Y.). Phys. Rev., 138: B689-91(May 10, 1965). (NYO-3399-05)

In connection with the problem of combining the relativistic invariance and internal symmetries, it has recently been shown by McGlinn and others that the mass splittings within a spin-degenerate multiplet are not possible via a theorem that states that, if an internal symmetry group commutes with the homogeneous Lorentz group, then it must commute with the translation group. Rather than considering the two subgroups of the inhomogeneous Lorentz group separately, if the invariants of the whole group are considered, it is found that it is not the generators $M_{\mu\nu}$ but rather the pseudovector $w_\mu = \frac{1}{2}\epsilon_{\mu\nu\lambda\sigma}M^{\nu\lambda}p^\sigma$ that is related to the spin of a particle. It is shown that if the set of generators of an internal symmetry group (assumed to be simple) commute with w_μ, then they have to commute with every generator of the inhomogeneous Lorentz group. Thus, the mass splittings are not possible. A few related theorems are also derived. (auth)

23413 LORENTZ INVARIANCE AND THE INTERPRETATION OF SU(6) THEORY. PART II. M. A. B. Beg and A. Pais (Rockefeller Inst., New York). Phys. Rev., 138: B692-7(May 10, 1965).

The relativistic completion of SU(6) is extended so as to take account of a more general form of the meson matrix. Low-frequency phenomena are discussed further. To order v/c all recoil effects are now included. The 70^- fermion representation is briefly treated. (auth)

23414 MULTICHANNEL EFFECTIVE-RANGE THEORY FROM THE N/D FORMALISM. Pran Nath (Univ. of California, Riverside) and G. L. Shaw. Phys. Rev., 138: B702-6(May 10, 1965).

An effective-range theory for systems of many coupled two-body channels is given using the N/D formalism. The effective-range expansion is carried out in the amplitudes M_{ij} (where M is essentially the matrix T^{-1} with the right-hand cut removed). Quite in analogy with the single-channel effective-range theory, the diagonal elements M_{ii} are given by an expression quadratic in k_i, the relative momentum in channel i. The effective ranges R_{ii} are given by certain principal-value integrals which depend on the position of the left-hand singularities in the corresponding channels and can be taken to be energy-independent to the same extent as in the one-channel theory. The nondiagonal elements M_{ij}, in general, have a weak energy dependence and can approximately be treated as constants. A two-channel computer experiment is performed to test these proposals in detail. Three different situations for the left-hand cut are considered: a set of monopoles, a set of dipoles, and the left-hand cut produced by the exchange of scalar particles in the crossed t reactions. For a large number of situations considered, the simple features proposed for the multichannel effective range theory were found to exist. The above formalism is similar to the multichannel effective-range theory of Ross and Shaw in the potential model. (auth)

23415 LARGE-ANGLE π^- + p ELASTIC SCATTERING AT 3.63 Gev/c. Martin L. Perl (Stanford Univ., Calif.), Yong Yung Lee, and Erwin Marquit. Phys. Rev., 138: B707-11(May 10, 1965). (SLAC-PUB-58)

The differential cross section for elastic scattering of 3.63-Bev/c mesons (π^-) on protons was studied with a

hydrogen bubble chamber, the emphasis being on large-angle scattering. From 90 to 180° in the barycentric system, the cross section is roughly flat with an average value of 2.7 ± 1.0 μb/sr. Near and at 180°, there may be a slight peak of magnitude 10 ± 6 μb/sr. But if such a peak exists, it is only one-third to one-fourth the size of the 180° peak found in 4.0 Bev/c $\pi^+ + p$ elastic scattering. In addition to comparison with other $\pi^- + p$ and $\pi^+ + p$ large-angle elastic-scattering measurements, this measurement is compared with large-angle $p + p$ elastic scattering. In the forward hemisphere a small peak or a plateau exists at $\cos\theta = +0.60$. This appears to be a second diffraction maximum such as has been found in lower-energy $\pi + p$ elastic scattering. A survey of indications of such a second diffraction maximum in other $\pi + p$ measurements shows that it always occurs in the vicinity of $-t = 1.2$ (Bev/c)^2, where t is the square of the four-momentum transfer. As the incident momentum increases, the relative size of this second maximum decreases. (auth)

23416 SPONTANEOUS SYMMETRY BREAKDOWN AND THE μ-e-γ INTERACTION. R. Arnowitt (Northeastern Univ., Boston) and S. Deser. Phys. Rev., 138: B712-23(May 10, 1965).

Spontaneous breakdowns of symmetries were examined for a system of two charged fields of zero bare mass (the muon and electron fields) interacting minimally with the electromagnetic field. Upon arranging the two fields into an isotopic doublet, the lagrangian is seen to possess SU(2) symmetry. Three possibilities are available: (a) no spontaneous breakdown of the SU(2) symmetry is allowed and the muon-electron system remains a degenerate doublet; (b) a partial breakdown occurs in which a mass splitting develops but the heavier muon remains stable; and (c) a complete breakdown occurs in which the muon decays into an electron plus a photon. Using the high-energy scheme of Baker, Johnson, and Willey, approximate solutions for the one-fermion Green's function and vertex function are examined. (The approximation scheme has the advantage that no ad hoc cutoffs need be invoked.) The solutions obtained permit case (b) to occur but not case (c), provided improper Lorentz invariance is imposed. It is shown, at least for the one-fermion Green's function, that no solution breaking P, C, or T invariance can arise. (auth)

23417 FURTHER EVIDENCE FOR PIGNOTTI'S R TRAJECTORY. Roger J. N. Phillips (Univ. of California, Berkeley) and William Rarita. Phys. Rev., 138: B723-5 (May 10, 1965). (UCRL-11830)

The high-energy K^+p and K^+n total cross section and the $K^- + p \rightarrow \overline{K}^0 + n$ charge-exchange data contain further evidence for the Regge trajectory R proposed by Pignotti. The signature factor is important in fitting these data; thus there is also some support for the Regge-pole hypothesis itself. (auth)

23418 COUPLED-CHANNEL SCATTERING WITH COMPLEX ANGULAR MOMENTUM. P. Kaus, Pran Nath, and Y. N. Srivastava (Univ. of California, Riverside). Phys. Rev., 138: B726-31(May 10, 1965).

A study of some problems in nonrelativistic multichannel scattering is made in the context of complex angular momentum. A generalization of the Mandelstam symmetry is obtained. It is shown that the well-known cusp behavior in the elastic cross section when an inelastic channel opens up is not only present for S waves, but is a persistent feature as the (real) angular momentum is varied continuously from $-\frac{1}{2}$ to $+\frac{1}{2}$. The existence of the indeterminacy points is indicated. Using the factorizability condition on the residues of the S matrix, it is explicitly exhibited how a part of the S matrix decouples when a resonance pole drifts to the real axis. (auth)

23419 FREQUENCY SHIFT IN HIGH-INTENSITY COMPTON SCATTERING. T. W. B. Kibble (Imperial Coll. of Science and Tech., London). Phys. Rev., 138: B740-53 (May 10, 1965).

The frequency shift predicted by Brown and Kibble, and by Goldman, for a photon scattered out of an intense beam by a free electron is reexamined. It is shown that the effect has a very simple classical interpretation, as a Doppler shift arising from the nonzero average velocity of the electron in the beam. The discrepancy between this prediction and the recent perturbation calculation of Fried and Eberly is shown to arise from the use, in the latter, of a pure monochromatic beam rather than a wave train of finite length. It is shown that the effect should arise for a quantized photon beam as well as for a classical one. The question of energy-momentum conservation is discussed. With the help of a one-dimensional model which exhibits all the essential features of the effect, it is shown that the extra energy and momentum which are generated in the scattering process are taken up by the beam itself in the form of an extremely small shift in the average momentum of a photon in the beam. The possibility of experimental detection of the effect is briefly discussed. (auth)

23420 IDEAL RELATIVISTIC BOSE CONDENSATION. P. T. Landsberg and J. Dunning-Davies (University Coll., Cardiff, Wales, G.B.). Phys. Rev., 138: A1049-52(May 17, 1965).

The condensation temperature and the specific-heat anomaly of an ideal relativistic Bose gas are discussed. For a high concentration of bosons with small rest mass there is a marked departure from the normal nonrelativistic theory. The heat capacity C_v remains continuous at the condensation temperature unless the rest mass vanishes. (auth)

23421 POSITRONIUM FORMATION IN METALS. H. Kanazawa, Y. H. Ohtsuki, and S. Yanagawa (Tokyo Univ.). Phys. Rev., 138: A1155-7(May 17, 1965).

A bound-state problem is solved for an extended Bethe-Goldstone equation which includes the short-range positron-electron interaction. It is concluded by numerical calculation that positronium formation is not possible in the usual range of the density parameter r_s. (auth)

23422 INTRINSIC PARITY OF MESONS AS QUARK-ANTIQUARK COMPOSITES. D. Lurie and Y. Takahashi (Dublin Inst. for Advanced Studies). Phys. Rev. Letters, 14: 653-4(Apr. 19, 1965).

It is pointed out that the prediction of the equations in the $\tilde{U}(12)$ scheme that the meson 35-plet must have negative parity if it is to transform as a quark-antiquark composite in the $\tilde{U}(12)$ group can also be made within the framework of $\tilde{U}(6) \otimes \tilde{U}(6)$ symmetry, assuming that the meson field transforms as a quark-antiquark composite under space reflections and baryon-number gauge transformations. (L.B.S.)

23423 SU(6) THEORY AND THE ANTIPROTON-PROTON ANNIHILATION AT REST INTO TWO MESONS. Freeman J. Dyson and Nguyen-huu Xuong (Univ. of California, San Diego, La Jolla). Phys. Rev. Letters, 14: 654-7(Apr. 19, 1965).

The rates of antiproton-proton annihilation at rest into two mesons are studied within the framework of SU(6) symmetry. The amplitude of the reaction is obtained using charge conjugation invariance, and predictions of the ratio of the rates of some reactions are made, which were found to disagree strongly with experimental rates. Possible sources of disagreement are given. (L.B.S.)

23424 MESON SYMMETRY. Richard C. Arnold (Univ. of California, Los Angeles). Phys. Rev. Letters, 14: 657-9(Apr. 19, 1965).

Evidence is presented for a broken chiral symmetry in the mass spectrum of mesonic states, and an interpretation of all well-established mesons is given in terms of a single family of Regge trajectories associated with the representation $(3,3^*) \otimes (3^*,3)$ of the group $SU(3)_L \otimes SU(3)_R$. The mesons are interpreted as bound states, primarily of baryon-antibaryon systems. (L.B.S.)

23425 SPURION THEORY OF BROKEN $U_\varphi(12)$ SYMMETRY. Reinhard Oehme (Univ. of Chicago). Phys. Rev. Letters, 14: 664-6(Apr. 19, 1965).

A $U_\varphi(12)$ theory is proposed where, in lowest order, the formal symmetry is broken not only by the imposition of Bargmann-Wigner equations, but simultaneously by the

insertion of a spurion. The spurion transforms like a component of the representation 143 which is an SU(3) singlet, and preserves the Lorentz invariance of the amplitudes. A relativistic formalism is obtained which reproduces the successes of models with SU(6) covariance, but is less restrictive than the intrinsically broken $U_{\mathcal{W}}(12)$ symmetry scheme. (L.B.S.)

23426 INTERPRETATION OF THE BASIC 20 IN SU(6)/Z(3). R. C. Casella (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Rev. Letters, 14: 666-8(Apr. 19, 1965).

It is postulated that in the static limit the physical group associated with the SU(6) algebra is SU(6)/Z(3), and it is shown that the representation 20 generates the physically allowed supermultiplets. The existence of 20 basic don states are then postulated, having usual charge and hypercharge quantum numbers, but distinguishable from the 56 baryons. In the SU(3) limit the model yields 9(= 8 + 1) one-don states. (L.B.S.)

23427 INTERPRETABILITY OF RELATIVISTIC SU(6) THEORIES. R. Mirman (Long Island Univ., Brooklyn). Phys. Rev. Letters, 14: 668-70(Apr. 19, 1965).

The difficulties associated with the interpretation of theories of combined internal and Poincaré invariance are discussed. An algebra is introduced which is a relativistic generalization of the algebra of SU(6) and which contains the momentum operators inbedded within it. The energy operator is chosen, which is not invariant under the internal group, and thus gives symmetry breaking. The diagonal elements of the matrix of this operator in any representation are the mass values of the eigenstates of the quantum number operators, and the off-diagonal elements are the matrix elements between different states. The presence of these off-diagonal elements necessitates the existence of interactions. (L.B.S.)

23428 W-SPIN AND B-SPIN SUBGROUPS OF SU(12). H. J. Lipkin (Weizmann Inst. of Science, Rehovoth, Israel) and S. Meshkov. Phys. Rev. Letters, 14: 670-2(Apr. 19, 1965).

SU(6) subgroups are presented which differ from the conventional SU(6) by the replacement of ordinary spin by different SU(2) subgroups of SU(12). The new subgroups, $SU(6)_W$ and $SU(2)_B$ are used to extend SU(6) calculations into the relativistic domain. Theories based on the transformation properties of a 12-component Dirac quark are considered. The W- and B- spin properties of Dirac matrices are tabulated. (L.B.S.)

23429 PARTICLE-MIXTURE THEORY AND APPARENT CP VIOLATION IN K-MESON DECAY. H. Ezawa, Y. S. Kim, S. Oneda, and J. C. Pati (Univ. of Maryland, College Park). Phys. Rev. Letters, 14: 673-6(Apr. 19, 1965).

A model is proposed for the two-pion decay mode of the $(K^0, \overline{K}^0)$ system subject to CP conservation, based on the particle-mixture theory. The model introduces a set of partner particles $(K'^0, \overline{K}'^0)$, with the requirement that the primed particles mix weakly with the unprimed ones depending upon their mass difference, and that they have a low production cross section and a decay rate to pions and leptons which is slower than that of the $(K^0, \overline{K}^0)$ system. An estimate of the mixing parameter is obtained based on the experiment of Christenson et al. (Phys. Rev. Letters, 13: 138(1964)). Other experiments are proposed for testing the mixing effect. (L.B.S.)

23430 ALGEBRA OF CURRENT COMPONENTS AND THEIR MOMENTS: AN INTERPRETATION OF SU(6). Benjamin W. Lee (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 14: 676-9(Apr. 19, 1965).

It is suggested that many of the successes of the nonrelativistic SU(6) can be explained in terms of the algebra of currents and the highly convergent nature of the relevant form factors in the dispersion-theory sense. Unitary symmetry is assumed for the dynamics of strong interactions. Commutation relations between the vector and axial-vector currents which generate the algebra U(6) ⊗ U(6) are obtained. The success of SU(6) is attributed to the correctness of the assumptions that the current integrals and the moment operators have the proper commutators, and the current integrals and the moment operators turn the $\frac{1}{2}^+$ octet into the $\frac{3}{2}^+$ decuplet and into itself. (L.B.S.)

23431 $\tilde{U}(12)$ AND NONLEPTONIC DECAYS. M. P. Khanna (Univ. of Rochester, N. Y.). Phys. Rev. Letters, 14: 711-13(Apr. 26, 1965).

The nonleptonic decays of hyperons are analyzed within the $\tilde{U}(12)$ symmetry scheme. In SU(6) theory, the parity-conserving (p-c) part of the weak interaction responsible for nonleptonic decays is assumed to transform as a spin-one object, while the parity-nonconserving (p-v) part transforms as a spin-zero object in the spin part of SU(6). In $\tilde{U}(12)$ theory one can distinguish between the p-c amplitude and the p-v amplitude by parity transformation rather than angular momentum. (C.E.S.)

23432 SU(6) PREDICTIONS FOR MESON-BARYON SCATTERING. V. Barger and M. H. Rubin (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 14: 713-14(Apr. 26, 1965).

With the usual SU(6) assignments of the baryons (octet + decuplet) to the 56-dimensional representation and the mesons (pseudoscalar octet + vector octet + vector singlet) to the 35-dimensional representation, the general form of the scattering operator for meson-baryon scattering contains four independent amplitudes. Amplitudes for pseudoscalar meson-nucleon reactions in the SU(6) symmetry model are presented. (C.E.S.)

23433 EXPERIMENTAL CHECK OF SOME SU(6) CROSS-SECTION EQUALITIES. T. Binford, D. Cline, and M. Olsson (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 14: 715-17(Apr. 26, 1965).

Relations between various amplitudes for meson-baryon scattering within the formalism of SU(6) theory are compared with available experimental evidence. The reactions $K^- + p \to \Lambda + \pi^0$, $K^- + p \to \Sigma^0 + \pi^0$, $\pi^- + p \to \Sigma^0 + K^0$, $\pi^- + p \to \Lambda + K^0$, $\pi^- + p \to \Sigma^- + K^+$, $\pi^+ + p \to \Sigma^+ + K^+$, $K^- + p \to \Xi^- + K^+$, and $\pi^- + p \to \Sigma^- + K^+$ are considered. (C.E.S.)

23434 W-SPIN ANALYSIS OF WEAK DECAYS IN $\tilde{U}(12)$. D. Horn (Tel-Aviv Univ., Israel), M. Kugler, H. J. Lipkin, S. Meshkov, J. C. Carter, and J. J. Coyne. Phys. Rev. Letters, 14: 717-19(Apr. 26, 1965).

The weak decays of baryons are investigated in the light of the relativistic extension of SU(6). The $\tilde{U}(12)$ theory is used. The calculation is simplified by the use of the W-spin technique. (C.E.S.)

23435 SPIN-2^+ MESON DECAYS IN BROKEN $\tilde{U}(12)$. R. Delbourgo, M. A. Rashid, and J. Strathdee (International Centre for Theoretical Physics, Trieste). Phys. Rev. Letters, 14: 719-21(Apr. 26, 1965). (IC/65/37)

The decays of the spin-2^+ meson octet ($2^+ \to 0^- + 0^-$, $2^+ \to 0^- + 1^-$) are considered. It was previously shown that these processes are forbidden by strict $\tilde{U}(12)$, and this is approximately the experimental situation in that the associated coupling constants are indeed small when due account is taken of the D-wave nature of the decay. An attempt is made to show that the assumption of symmetry breaking by kinetic spurions leads to reasonably good comparisons with the known partial decay widths of these mesons. For the sake of definiteness the 2^+ particles are assigned to the 4212^+ multiplet of $\tilde{U}(12)$, which accommodates a nonet of vector mesons. (C.E.S.)

23436 EXPERIMENTAL DETERMINATION OF BRANCHING RATIOS OF VECTOR MESONS INTO LEPTON PAIRS. R. A. Zdanis (Johns Hopkins Univ., Baltimore), L. Madansky, R. W. Kraemer, S. Hertzbach, and R. Strand. Phys. Rev. Letters, 14: 721-4(Apr. 26, 1965). (BNL-8907)

The decay of neutral vector mesons ($V^0 = \rho, \varphi$, or ω) into leptons ($l = \mu$ or e) was studied in the reaction $\pi^- + p \to n + V^0$ with the subsequent decay $V^0 \to l^+ + l^-$ using a system of scintillation counters and spark chambers. The measured branching ratios were a factor of 10 lower than previously measured upper limits for the electron decay modes. (C.E.S.)

23437 MUON-PROTON SCATTERING AT HIGH MOMENTUM TRANSFERS. R. Cool (Brookhaven National Lab., Upton, N. Y.), A. Maschke, L. M. Lederman, M. Tannenbaum, R. Ellsworth, A. Melissinos, J. H. Tinlot, and T. Yamanouchi. Phys. Rev. Letters, 14: 724-8(Apr. 26, 1965).

The results of an experiment to observe meson (μ^-) scattering by protons at high momentum transfers are reported. A comparison of the results with similar electron scattering data provides a sensitive test of any presumed difference in the charge structure of the leptons. The data reported consist of about 500 scattering events with momentum transfer in the interval 700 to 1100 Mev/c. They indicate no significant difference between μ-p and e-p scattering. (C.E.S.)

23438 SU(n) SYMMETRY OF TRILINEAR INTERACTIONS. A. K. Bose and J. Patera (Universite, Montreal). Phys. Rev. Letters, 14: 729-30(Apr. 26, 1965).

It is shown that the Smushkevich principle leads to the SU(n) invariance of the trilinear interaction between one (n^2-1) multiplet and two d_n multiplets, were d_n can be the dimensionality of any possible irreducible representations of the group SU(n). The derivation of SU(n) invariance does not require the use of any perturbation equations. (C.E.S.)

23439 EVIDENCE FOR THE PHOTOPRODUCTION OF Y = 0 STATES WITH MASSES GREATER THAN 1900 Mev. W. A. Blanpied, J. S. Greenberg, V. W. Hughes, P. Kitching, D. C. Lu, and R. C. Minehart (Yale Univ., New Haven). Phys. Rev. Letters, 14: 741-4(May 3, 1965).

Evidence for the existence of Y = 0 states with masses greater than 1900 Mev obtained from studies of the associated photoproduction of mesons (K^+) with neutral Y = 0 hyperons is reported. The reactions studied were $\gamma + p \rightarrow K^+ + Y^*$, in which the production angle and momentum of the K^+ were measured. Identification of the various Y = 0 states is based on kinematics and presumes that the reactions proceed primarily through the two-body final states. (C.E.S.)

23440 SEARCH FOR ANOMALOUS π^+ DECAY AMONG τ^+ DECAY SECONDARIES. S. Taylor, E. L. Koller, T. Huetter, P. Stamer, and J. Grauman (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev. Letters, 14: 745-6(May 3, 1965).

A previous proposal that the apparent CP nonconservation in K_2^0 decay could be explained if there existed a particle of mass close to the meson(π) mass but with nonzero spin and if at least one of the secondaries in the 2π decay mode of K_2^0 were one of these new particles is considered. The decays of 1190 mesons(π^+) from meson(τ^+) decay were examined. The experimental data show no indication of asymmetry in the $\pi^+ \rightarrow \mu^+$ decay angle for mesons(π^+) in the energy range 0–12 Mev. The data show no evidence for an anomalously large branching ratio for $\pi^+ \rightarrow e^+$ decay. Hence the experiment provides no evidence for the existence of a new particle with nonzero spin of approximately the meson(π) mass. (C.E.S.)

23441 ABSORPTIVE CORRECTIONS TO THE ONE-MESON-EXCHANGE MODEL IN S-MATRIX THEORY. James S. Ball (Univ. of California, Los Angeles) and William R. Frazer. Phys. Rev. Letters, 14: 746-9(May 3, 1965).

The one-meson-exchange (OME) model modified by the inclusion of absorptive corrections has met with impressive success, at least for scalar meson exchanges. The formula used is to expand the OME scattering amplitude B(W) in partial waves $B^J(W)$ and to make the replacement $B^J(W) \rightarrow [S^J_{11}(W)]^{\frac{1}{2}} B^J(W) [S^J_{22}(W)]^{\frac{1}{2}}$ where W is the total energy in the cms, S^J_{11} is the partial-wave S-matrix in the incident channel (1), and S^J_{22} is the partial-wave S-matrix in the final channel (2). A derivation of this equation within the framework of S-matrix theory is presented. (C.E.S.)

23442 DETERMINING THE CP ADMIXTURE OF NEUTRAL K MESONS. R. R. Lewis (Univ. of Michigan, Ann Arbor and Universite, Geneva). Phys. Rev. Letters, 14: 749-52(May 3, 1965).

The possibility of determining the CP admixture of mesons (K^0) by observation of the CP nonconservation in a coherent meson (K^0) beam in matter is discussed. The forward scattering in the medium induces CP admixtures of known phase and with amplitudes proportional to the density, which add coherently to the intrinsic CP admixtures. Hence by measuring the magnitude of any CP-nonconserving effect versus the density of the medium, these two admixtures can be made to interfere, and both the phase and magnitude of the intrinsic admixture can be determined. The possibility of providing a reference admixture which is adjustable in both phase and magnitude is also discussed. (C.E.S.)

23443 SU(12) MASS FORMULA. L. Castell (Trinity Coll., Dublin). Phys. Rev. Letters, 14: 753-4(May 3, 1965).

The SU(12) symmetry of elementary particles and U-spin multiplets is discussed. It is assumed that the full SU(12) symmetry of the mass operator is broken by an interaction which does not conserve U spin and that the resulting mass splitting is proportional to the expectation value of U spin. Two mass relations for a U-spin quartet and one mass relation for each of the four U-spin triplets are obtained. (C.E.S.)

23444 NUCLEON MAGNETIC MOMENTS IN COVARIANT VERSION OF WIGNER'S SUPERMULTIPLET THEORY. A. J. Macfarlane, L. O'Raifeartaigh, and E. C. G. Sudarshan (Syracuse Univ., N. Y.). Phys. Rev. Letters, 14: 755-7(May 3, 1965).

Among the most notable features of the covariant $\tilde{U}(12)$ generalization of the nonrelativistic SU(6) theory are (a) the derivation of an experimentally quite reasonable absolute value for the proton magnetic moment, (b) the prediction of the value $-\frac{3}{2}$ for the ratio of the proton and neutron magnetic moments and (c) the occurrence of a single baryon form factor. A covariant $\tilde{U}(8)$ generalization of the SU(4) theory is developed, and it is shown how the features (a), (b), and (c) are contained in it. (C.E.S.)

23445 NONLEPTONIC HYPERON DECAY AND THE RELATIVISTIC GENERALIZATION OF SU(6). S. P. Rosen (Purdue Univ., Lafayette, Ind.). Phys. Rev. Letters, 14: 758-61(May 3, 1965).

A relativistic generalization of SU(6) is made which yields the true relation between orbital angular momentum and spin. The S- and P-wave amplitudes for the nonleptonic decays of hyperons (Σ^+), (Σ^-), (Λ), and (Ξ^-) are obtained. The S-wave amplitudes are exactly the same as those computed in SU(6), but the P-wave amplitudes include several new terms that do not appear in SU(6). (C.E.S.)

23446 EXISTENCE OF PIONS WITH SPIN. G. Rinaudo, A. Marzari-Chiesa, G. Gidal, and A. E. Werbrouck (Istituto Nazionale di Fisica Nucleare, Turin, and Universita, Turin). Phys. Rev. Letters, 14: 761-3(May 3, 1965).

It was previously proposed that one of the secondaries from $K_2^0 \rightarrow \pi^+ + \pi^-$ decay is not a normal pion but a pion with spin (spion). Several consequences follow from this assumption: (a) the ratio of the decay rates for electronic and muonic modes should be comparable for the charged spion. (b) If the spin of the spion is 1 and neutral spions exist, the preferred decay mode would be into an electron-positron pair plus a photon. Assuming a very short lifetime ($\leq 10^{-12}$ sec), one expects to observe in a bubble chamber an anomalous number of Dalitz pairs in K^+ decays. Hypothesis (a) was checked in τ and τ' decay, and hypothesis (b) was checked in τ', in $K_{\mu 3}$, and in all K^+ decays involving a π^0. No evidence of the effects were found, all the results being compatible with a completely normal behavior of the pions from K^+ decays. The data were obtained from two exposures of the bubble chamber to beams of stopping K^+ mesons. (C.E.S.)

23447 SMALL-ANGLE CHARGE EXCHANGE OF π^- MESONS BETWEEN 6 AND 18 Gev/c. A. V. Stirling (Centre d'Etudes Nucleaires, Saclay, France), P. Sonderegger, J. Kirz, et al. Phys. Rev. Letters, 14: 763-7 (May 3, 1965).

The results on π^-p charge-exchange scattering at 5.9, 9.8, 13.3, and 18.2 Bev/c are reported. The behavior of the differential cross section is discussed. (C.E.S.)

23448 CORRECTIONS OF MULTIPLE COULOMB SCATTERING TAKING INTO ACCOUNT IONIZATION LOSSES. V. F. Grushin and E. M. Leikin (Inst. of Physics, Academy of Sciences, USSR). Pribory i Tekhn. Eksperim., No. 1, 52-3(Jan.-Feb. 1965). (In Russian)

The calculations of the corrections, taking into account losses generated by multiple Coulomb scattering of particles were given for the cases when it is possible to neglect by means of the ionization losses the energies in delaying filters. (tr-auth)

23449 ON THE CONCEPT OF ANTI-PARTICLE. K. Ono. Soryushiron Kenkyu, 27: 1-2(1963). (In Japanese)

It is pointed out that the non-conservation of parity in weak interaction does not suggest that the symmetry for mirror image transformation is violated by the natural law. For instance, the cause of the violation of the symmetry of mirror image transformation in the optical rotation of the asymmetry molecule is the asymmetry of the structure of the optically rotating molecule rather than the asymmetry of the natural law. It is also the case for elementary particles. If some elementary particles exist, so do their mirror image particles. It is suggested that the particles and anti-particles are related to each other as optical isomers i.e. the proton and antiproton, the electron and positron, etc. are to each other related mirror images. The elementary particle which is symmetrical to its mirror image transformation is therefore a Majorana particle and those asymmetrical to its mirror image Dirac particle. The CP invariance can be described in terms of the previous explanation. Since the anti-particle is described as the hole in the negative energy state in relation to Dirac equation, it is not to be generalized. For instance, the Dirac equation would be meaningless if the space is distorted, but the concept of matter and anti-matter is not related to the distortion of space. The general concept for anti-matter may therefore be given on the basis of the above explanation. (auth)

23450 30-, 60-Mev NUCLEON-NUCLEON SCATTERINGS. S. Miyachi. Soryushiron Kenkyu, 27: 53-74(1963). (In Japanese)

The nucleon-nucleon scattering amplitudes are calculated in terms of nonrelativistic approximation using the dispersion relation. The contributions of one-pion exchange and two-pion exchange based on the fourth order diagram to the scattering amplitudes are obtained and compared with the scattering amplitudes obtained by the experimental values given in the analysis of 30 and 60 Mev proton-proton and proton-neutron scatterings by the Hamata potential. The results show that the scattering amplitudes are not entirely consistent with the experimental values in 30 and 60 Mev scatterings when the effects of (3,3) resonance are taken into account. (L.B.S.)

23451 NOTE ON π-HYPERON COUPLING CONSTANTS. M. Uehara. Soryushiron Kenkyu, 27: 75-80(1963). (In Japanese)

The problem of obtaining the relations for the coupling constants of πY interactions is considered in terms of the dispersion relation for $P_{\frac{1}{2}}$ partial wave. The calculation is made using the bootstrap relation and neglecting multi-channel effects and the influence of π-π and K-π interaction. The close relation between the interaction of $(\Sigma\Sigma\pi)$ and the spin-parity of Y_0^* is also shown by the $P_{\frac{1}{2}}$ wave. (L.B.S.)

23452 REGGE ASSUMPTION AND THEORY OF ELEMENTARY PARTICLES. T. Kamiyoshi. Soryushiron Kenkyu, 27: 81-90(1963). (In Japanese)

Some problems of elementary particles and their relation to the Regge assumption are discussed. The compound particle is defined as the bound state in non-relativistic quantum theory, and the absence of Regge behavior is explained by the N-θ scattering in the Lee model. It is shown by using the dispersion relation and the analytical extension of scattering amplitudes in the angular momentum plane that the problem of whether the particle possesses an elementary particle core may be determined by the extended scattering amplitude in that plane, and can be checked with the angular distribution of scattering at high energy. The extensions of Pomeranchuk particles, the baryon family, and the meson family are discussed, along with the relativistic theory for the slope of the trajectories. (L.B.S.)

23453 THE MEASUREMENT OF SPIN CORRELATION COEFFICIENT. K. Nishimura. Soryushiron Kenkyu, 27: 91-3(1963). (In Japanese)

The spin correlation coefficient C_{kp} of 52 Mev p-p scattering was measured at 90° in the center of mass system. A proton beam from a 160 cm synchrocyclotron was scattered by a polyethylene target and then by a carbon target placed 2 m from the first. The double scattering was measured by four sets of counters, and coincidence measurements were made using another four coincidence counting circuits. The value $C_{kp} = 0.10 \pm 0.14$ was obtained. (L.B.S.)

23454 MATRIX ELEMENTS OF τ,τ' AND η-3π DECAYS AND UNITARY SYMMETRY. Kanezawa. Soryushiron Kenkyu, 27: 143-52(1963). (In Japanese)

The effective interaction which satisfied the $\Delta I = \frac{1}{2}$ rule and T-invariance is used to calculate the matrix elements containing 2-, p-waves in $\eta \rightarrow \pi^+ + \pi^- + \pi^0$ and τ,τ' decays in terms of Boson pole approximation, and to obtain the asymmetry parameters, $\alpha_\eta, \alpha_\tau, \alpha'_\tau$, in these decays which can be compared with the experimental results of the Columbia group and the experimentally verified relation, $\alpha_\eta^{\ell} = -2\alpha_\tau$. (L.B.S.)

23455 THE WEAK INTERACTION WITH VARYING STRANGENESS. T. Katayama and K. Matsumato. Soryushiron Kenkyu, 27: 196-217(1963). (In Japanese)

The 6-body weak interaction with varying strangeness and the 6-body coupling between elementary particles and leptons are discussed in the Sakata model. The hamiltonians for the 6-body weak interactions relating to Λ particle and the lepton are obtained. Decay rates for the K^+/K_1^0, K_1^0/K_2^0, $K^0/\overline{K}^0$, Σ^+/Σ^-, $K_{2\pi}$ decays K^+/K^0 and $K^0/\overline{K}^0$ are calculated. The asymmetrical parameters for Λ and Σ decays are found to agree with experiment. The properties of isospace and possible extensions of the 6-body coupling are considered. (L.B.S.)

23456 THE CLASSICAL MODEL OF ELEMENTARY PARTICLES. Y. Yano. Soryushiron Kenkyu, 27: 295-303 (1963). (In Japanese)

The classical model of the mass spectrum of elementary particles is obtained applying the mass-energy relation of the relativistic theory. The conditions for the rest energy of a particle are given, and assumptions are made for obtaining the velocity relating to the vibration frequency of the wave. The rest mass is given for the photon, electron, nucleon, hyperon, and other particles. (L.B.S.)

23457 THE RADIATION CORRECTIONS OF μ- AND β-DECAYS. T. Kinoshita. Soryushiron Kenkyu, 27: 386-94 (1963). (In Japanese)

The radiation corrections of μ and β decays are discussed in terms of the V-A theory. The spectrum of μ decay is obtained by using the perturbation theory, and the Michel parameters of angle-independent and angle-dependent parts are determined. (L.B.S.)

23458 NON-LEPTONIC DECAY OF HYPERONS. Z. Maki and M. Nakagawa. Soryushiron Kenkyu, 27: 443-9 (1963). (In Japanese)

It is pointed out that the weak effective interaction and the structures of hyperons are not mutually adaptable. The results of α_{Σ^0} and α_Λ were found to be in agreement with experiment when the Σ and Λ were regarded as $\Sigma \equiv [NK]_{I\rightarrow 1}$ and $\Lambda \equiv [NK]_{I\rightarrow 0}$. The relation between the experimental rates of Σ and Λ decays without phase volume are obtained. It is also shown that Ξ consists of two configurations $[\Sigma K]$ and $[\Lambda\overline{K}]$ in almost equal proportion. (L.B.S.)

23459 THE WEAK INTERACTION WITH CHANGING STRANGENESS. T. Katayama and K. Mastumoto. Soryushiron Kenkyu, 27: 450-5(1963). (In Japanese)

The weak interaction of $\Delta S \pm 0$ is considered entirely as a 6-body interaction and written in the form of the weak current product. The $\Lambda \approx N$ interaction is uniquely defined, and the probabilities of the leptonic and non-leptonic decays of mesons (K) are discussed. (L.B.S.)

23460 THE ANALYSIS OF LOW ENERGY π-N SCATTERING BASED ON OBEC MODEL. Soryushiron Kenkyu, 27: 464-87(1963). (In Japanese)

The S, P, and D phase shifts of π-N scattering at 0 to 500 Mev pion energy in a laboratory system are analyzed by the use of OBEC model, with considerations for the contributions from N*, N**, ρ meson, and the ABC meson. The π-N phase shifts are obtained through unitarization, and the results are analyzed. (L.B.S.)

23461 THE POSSIBLE EXISTENCE OF A NEW KIND OF INTERACTION. K. Matumoto. Soryushiron Kenkyu, 27: 488-95(1963). (In Japanese)

The possible existence of a new kind of interaction between e, μ, ρ, n, and Λ due to short range interactions between charged leptons and B^+ is discussed. The interaction has an effect on e(μ)-N scattering of high momentum transfer, the $e(\mu) + e^+(\mu^+)$ transitions of the neutral particles (η, K_1^0, K_2^0), and the nuclear 0−0 transition emitting $e + e^+$. (L.B.S.)

23462 NOTE ON THE ^3P PHASE SHIFTS IN LOW ENERGY P-P SCATTERING—NOTE ON THE EFFECT OF ELECTROMAGNETIC INTERACTION. Y. Yamaguchi. Soryushiron Kenkyu, 27: 517-19(1963). (In Japanese)

It is noted that the nuclear contribution of p-p scattering to the ^3P_j phase shifts would be small in the region of $E \lesssim 10$ Mev if the nuclear force is of the Serber type. The vacuum polarization and contributions from interactions caused by magnetic moments is spin-independent, thus the splitting of these phase shifts may be disregarded. Only the effect of the splitting of ^3P_j phase shifts of the Thomas spin-orbital force (LS force) is considered, and at low energy this contribution is shown to be large. It is then noted that all contributions from electromagnetic interactions must be considered for p-p phase shifts at $E \lesssim 10$ Mev. (L.B.S.)

23463 NON-STATIC POTENTIAL IN NUCLEON-NUCLEON SCATTERING (TRIPLET ODD). R. Tamagaki and M. Wata. Soryushiron Kenkyu, 27: 520-31(1963). (In Japanese)

The properties of the two-body potential are analyzed using the experimental value of the spin correlation parameter C_{kp} in scattering. The form of the potential is given and the phase shift of ^3P_j, ^3H_j, and ^3F_j is calculated for several sets of parameters. An analysis of the results is presented. (L.B.S.)

23464 ON THE RECONSTRUCTION OF THE MOMENTUM DISTRIBUTION OF ANNIHILATING ELECTRON-POSITRON PAIRS FROM THE ANGULAR CORRELATION OF GAMMA QUANTA. P. U. Arifov, V. I. Gol'danskii, and Yu. S. Sayasov (Inst. of Chemical Physics, Moscow). Soviet Phys.-Solid State (English Transl.), 6: 2484-7(Apr. 1965). Translated from Fiz. Tverd. Tela, 6: 3118-23(Oct. 1964).

In studies of the momentum distribution of free and valence electrons in solids, a method based on the observation of the angular correlation of gamma quanta emitted during the annihilation of positrons has been widely used. It is shown that under real conditions, the approximate formula which is normally used to find the momentum distribution by this method may lead to large errors. Relations for the solution of this problem, properly including the experimental geometry and the kinematic properties of the gamma quantum scattering, are derived. (auth)

23465 NEUTRINOS IN THE LABORATORY AND IN THE UNIVERSE. Bruno Pontecorvo. Tehn. ja Tootmine, No. 7, 34-8(1964). (In Estonian)

The history of the discovery of the neutrino is recapitulated; mention is made of the postulating of the neutrino to explain the discrepancy between observed and calculated values of the energy of beta particles emitted in beta decay. The experimental demonstration that the neutrino and antineutrino have different spins is discussed. Analysis of cosmic neutrinos, which reveal processes occurring inside bodies in the universe, is suggested for use in cosmogony. (M.J.T.)

23466 ELECTRIC GENERATION OF STRANGE PARTICLES AT HIGH ENERGIES. M. P. Rekalo. Ukr. Fiz. Zh., 10: 245-59(Jan. 1965). (In Ukrainian)

On the basis of the hypothesis of Regge poles in the region of angles of approximately 180° the amplitude of the process of electric formation of mesons (K) at high energies is obtained. Two possible variations of the intrinsic parity of the system (KNY) are considered. The asymptotic amplitudes are represented in factorized form, corresponding to the contributions of two Feynman diagrams describing the region regime. The spiral amplitudes, which are oscillating functions of the energy and angle of formation, are calculated, the contribution of the longitudinal polarization of the virtual photon being asymptotically less than that of the cross polarization. Various observed characteristics of the process of electric generation of mesons (K) are calculated. (auth)

23467 THE INTERACTION OF 300 Mev/c K^- MESONS WITH EMULSION NUCLEI. J. P. Lagnaux (Universite Libre, Brussels), J. Lemonne, L. Bishara, M. A. Hussain, and N. N. Raina. Univ. Bruexelles, Inst. Phys., Bull., No. 19, 32p.(Dec. 1964).

A detailed analysis of 1000 stars produced by the interactions of 50- to 300-Mev/c mesons(K^-) with the emulsion nuclei is presented. The emission rates of stable baryons of energies exceeding 60 Mev, charged hyperons(Σ) and mesons(π) are, respectively, 21 ± 2, 13.5 ± 2.2 and 27.5 ± 2.7%. The latter values, when compared to those obtained for absorptions at rest, lend support to the model of peripheral absorption of stopped mesons(K^-). The energy spectra and the angular distributions of hyperons($\Sigma^\pm$) emitted respectively with or without a charged meson(π) are found to be different. These results suggest that nonmesonic interactions contribute to slow meson(K^-) absorptions in flight. (auth)

23468 VERTEX PART OF NND IN LOW-ENERGY REGION AND BINDING ENERGY OF THE DEUTERON. M. A. Braun and A. N. Vasil'ev. Vestn. Leningr. Univ., No. 22, Ser. Fiz. i Khim., No. 4, 61-70(1964). (In Russian)

General equations are developed for the discontinuities in the G and Γ vertices at low energy, expressing these discontinuities by partial amplitudes of the $\pi N \to \pi N$ and $\pi N \to \bar{N}D$ reactions respectively; a method previously developed for spinless particles is used for the particles with spin. The first anomalous thershold for the Γ vertex is calculated specifically. A more exact solution for the G vertex in the unitarity equation for the Γ vertex would depend on a parameter associated with a nonphysical function of the G vertex. (M.J.T.)

23469 INFLUENCE OF THE INTERACTIONS IN FINAL STATE ON THE ELECTRODISINTEGRATION OF DEUTERONS IN THE REGION OF THE THRESHOLD. Dietrich Braess (Freie Hansestadt, Hamburg). Z. Physik, 184: 241-70(1965). (In German)

Dispersion relations are used to calculate the $l = 0$ matrix element for the electrodisintegration of the deuteron. To treat the final state interaction, the phase shifts for the nucleon-nucleon scattering were taken from experiment. Approximations for the cuts often used in connection with dispersion relations are considered in the framework of potential theory. An effective range approximation is discussed. For the singular integral equations which occur in problems of this kind a solution is given, avoiding the difficulties that otherwise may arise from the deuteron pole. (auth)

23470 THEORY OF MULTIPLE SCATTERING. Yu. N. Gnedin and A. Z. Dolginov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 548-60(Feb. 1965). (In Russian)

Multiple scattering of particles or quanta on a plane layer of matter is considered for the case of anisotropic scattering on a force center. An explicit analytic solution of the transfer equation is obtained for cases when expansion of the cross section into Legendre polynomials possesses a finite number of terms and when the cross section has a sharp peak at small angles (Coulomb scattering). (auth)

23471 KINEMATIC SINGULARITIES OF HELICITY AMPLITUDES. INTEGRAL SPINS. M. S. Marinov and V. I. Roginskii. Zh. Eksperim. i Teor. Fiz., 48: 673-83 (Feb. 1965). (In Russian)

The general relation between helicity and tensor amplitudes is used for determining the kinematic singularities (root branches, poles, and zeros) of the helicity amplitudes for the processes $1 + 2 \rightarrow 3 + 4$ and $1 \rightarrow 2 + 3$ as functions of invariant variables. The case of integral spins is considered. (auth)

23472 ON THE RELATION BETWEEN FIELDS AND SPIN PARTICLES. V. S. Mineev and Yu. M. Shirokov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 719-22(Feb. 1965). (In Russian)

A method for obtaining the physical quantities characterizing a corpuscular description is extended to the case of particles possessing a spin; the physical quantities are derived from the matrix elements $\langle\alpha|A(x)|\alpha'\rangle$ of a scalar neutral quantum field A(x) which are prescribed in an arbitrary basis α. Transition to a corpuscular description means that one determines the mass κ and spin j spectrum of all stable particles; the set of quantities $\langle\alpha|0\rangle$, $\langle\alpha|\kappa_1 j_1 k_1 m_1\rangle$, $\langle\alpha|\kappa_1\kappa_2 j_1 j_2 k_1 k_2 m_1 m_2\rangle$, ..., which constitute the transition matrix from the initial basis to the in-basis in which the particle state is defined by its momentum k and spin projection on the z axis, m, prescribed at minus infinity in time and the scattering matrix. The method is applicable to local quantities of any physical nature or tensor dimension. (auth)

23473 QUANTUM OPTICS AND ELECTRONICS. Lectures delivered at Les Houches during the 1964 Session of the Summer School of Theoretical Physics, University of Grenoble. C. DeWitt, A. Blandin, and C. Cohen-Tannoudji, eds. New York, Gordon and Breach, Science Publishers, 1965 627p.

Eight articles are presented. An introduction to the quantum theory of radiation, emphasizing the basic quantum interaction between radiation and matter and its relation to classical theory, is provided. The concept of optical coherence is defined in quantum mechanical terms, and statistics of light beams are discussed. Optical pumping experiments, in which angular momentum is transferred from photons to atoms, are described. A theoretical description of optical masers is given. Recent research in gaseous optical masers is presented. Research in nonlinear optics, including harmonic generation, Raman lasers, and parametric amplification, is surveyed. Optical masers made of semiconducting and paramagnetic materials are reviewed. Problems of spectral-line shape and line-broadening mechanisms in various frequency ranges are considered. (M.J.T.)

23474 EXPERIMENTS WITH HIGH-ENERGY NEUTRINOS. H. Faissner (CERN, Geneva). p.125-56 of "Physikertagung Hamburg." Mosbach/Baden, Ger., Physik Verlag, 1964. (In German)

The most important studies on the neutrino are critically reviewed. The accelerator as the source of high-energy neutrino, weak interactions at low energies, weak interactions with muons, the one- or two-neutrino question, structure revealed by the strong interaction of nucleons, structure in the weak interaction itself, inelastic reactions and abnormal processes, neutrino experiments at Brookhaven, the CERN neutrino beam, the detectors used at CERN, and the preliminary results of the CERN research are discussed. (J.S.R.)

23475 INTERMEDIATE PARTICLES IN S-MATRIX THEORY AND CALCULATION OF HIGHER ORDER EFFECTS IN THE PRODUCTION OF INTERMEDIATE VECTOR BOSONS. Martinus Justinus Godefridus Veltman. Thesis, Utrecht, Rijksuniversiteit, [1963]. 56p.

The problems of unitarity, causality, and renormalizability are treated in a field theory containing an unstable particle. Perturbation theory is suitably modified and leads to an implicit equation for complete propagators. The S-matrix constructed with these propagators and connecting stable particle states only is shown to be unitary, renormalizable and causal. It is also shown to give rise to interpolating Heisenberg fields which verify the original field equations. The wave function for a vector boson in a Coulomb field is obtained in a high energy approximation. The Furry wave function for a lepton in a Coulomb field is reconsidered and extended. Both wave functions are then applied to the coherent production of vector bosons and muons by neutrinos in the Coulomb field of the nucleus. For low-energy muons the matrix element is improved by taking into account all second order effects for the muon. The effect of nuclear structure is briefly discussed. (auth)

23476 DISTRIBUTION OF 4-MOMENTUM TRANSFER OF 5 Bev/c MUONS IN NUCLEAR EMULSION. P. L Jain. 4p. (CONF-641210-6)

From American Physical Society Meeting, Berkeley, Calif.

A stack of Kodak NTB-4 nuclear emulsions was exposed to a beam of 5-Bev/c mesons(μ^-). The total inelastic meson(μ^-) cross section was determined to be ~93 μb, while the cross section for inelastic processes in which charged mesons(π) were produced was found to be ~19 μb. The angular distributions of the mesons(μ) and of the secondary particles were obtained, and the distributions of four-momentum and energy transferred to the target particle were analyzed by several theories. The total inelastic and pion production cross sections for the photons associated with the incident mesons(μ) were calculated by the various theories. (D.C.W.)

23477 PERIPHERAL PRODUCTION OF SINGLE PIONS AND KAONS BY NEUTRINOS. C. E. Thompson. 14p. (CONF-641210-7)

From American Physical Society Meeting, Berkeley, Calif.

The effects of form factors on the cross sections and boson spectra for peripheral production of single mesons(K) and (π) by neutrinos on nucleons were investigated theoretically. (D.C.W.)

23478 VERY HIGH ENERGY P-P ELASTIC SCATTERING IN A FUNDAMENTAL LENGTH FIELD. D. T. Bailey and R. L. Ingraham, (New Mexico State Univ.). 5p. (CONF-641004-5)

From American Physical Society, Chicago.

A fundamental length (high momentum cut-off) was previously incorporated into quantum field theory by treating the underlying space-time coordinates as a manifold of stochastic variables with non-zero dispersion. The theory was previously applied to very high energy p-p elastic scattering, considering only dispersion in the spatial coordinates. The results of considering dispersion in both space and time coordinates are reported. (D.C.W.)

23479 EFFECT OF ION ENGINE EXHAUST ON THE PROPAGATION OF ELECTROMAGNETIC WAVES. A. R. M. Rashad (Univ. of Detroit). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-186, 18p, $1.00. (CONF-650209-1)

From AIAA 6th Solid Propellant Rocket Conference, Washington, D. C.

A theory is presented concerning the effect of the ion energy exhaust on the propagation, interaction and scattering of incident electromagnetic waves originating from a nearby dipole antenna. The exhaust is represented as a cylindrical beam. Two cases of interest are studied: exhaust beam in an axial d-c magnetic field $B_z = 0$; and that of a finite value B_z respectively. The electromagnetic field equations are obtained for TM modes in the first case, and for TE modes in the second case. The analysis considers also the changes in the beam temperature due to its interaction with the surrounding medium. This temperature change is found to be anisotropic in the case $B_z \neq 0$. The fluctuations in the coefficients of the tensor dielectric constant due to the temperature changes, and their effect on the electromagnetic field expressions are also studied in detail. (auth)

Field Theory and Quantum Mechanics

23480 (JINR-E-1962) SPONTANEOUS BREAKDOWN OF SYMMETRIES IN QUANTUM FIELD THEORY. G. Domokos and P. Suranyi (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1965. 20p. Dep.(mn).

Symmetry breaking solutions in quantum field theory are dealt with by means of functional methods. It is shown that if the normal solution if renormalizable, then the symmetry-breaking solution is renormalizable as well. The Goldstone theorem is proved for orthogonal symmetry groups. In the case of SU(3) symmetry the preferred direction in unitary space is uniquely determined by the self-consistency condition: it coincides with the hypercharge axis. The general procedure is illustrated on the example of a self-coupled scalar field. Approximate calculations are performed by means of a generalized diagram technique. The validity of the Gell-Mann-Okubo mass formula is discussed independently of perturbation theory. Some unsolved problems of principal character are indicated. (auth)

23481 GAUGE-INDEPENDENT THEORY OF SYMMETRY. PART II. H. A. Buchdahl and L. J. Tassie (Australian National Univ., Canberra). Australian J. Phys., 18: 109-17(Apr. 1965).

A gauge-independent symmetry theory of non-relativistic quantum mechanical systems is developed, in line with that previously considered in the context of classical mechanics. The motivation for adopting the view that the invariance of a system K under a physical symmetry operation $\mathcal{P}$ should be taken to mean invariance of the equation of motion of K under a certain gauge-independent unitary transformation $U_c(\mathcal{P})$ is first discussed. The formal development of the theory is then carried through, and some detailed examples are presented. In particular, corresponding to every direction along which a system K happens to be translationally invariant, there exists a gauge-independent generator of translations which leaves K invariant but which is not, in general, a component of either the canonical or the kinetic momentum. The connection between such invariant generators of translations and the so-called magnetic translation operators is referred to. (auth)

23482 ON A CORPUSCULAR MODEL OF SPIN $\hbar/2$ — SPIN FIELD $\hbar/2$ DESCRIBED BY A SYSTEM OF NON-LINEAR WAVE EQUATIONS AND THE QUANTUM THEORY OF THE ASSOCIATED FIELDS. Gerard Petiau (Universite, Paris). Compt. Rend., 260: 1107-10(Jan. 25, 1965). (In French)

A system of non-linear wave equations describing a corpuscle of spin $\hbar/2$ accompanying a system of fields of the same variance was studied. A quantum theory of fields associated with this model was introduced. (tr-auth)

23483 THE DEVELOPMENT OF QUANTUM THEORY. R. E. Peierls (Oxford Univ.). Contemp. Phys., 6: 129-39 (Dec. 1964).

The development of quantum theory is briefly discussed, with consideration of the quantum concept, the quantum theory of the atom, the exclusion principle, the wave-particle relation, and the uncertainty principle. (D.C.W.)

23484 FIELD DIFFRACTION OF AN IRREGULARLY MOVING CHARGED PARTICLE IN A SEMI-INFINITE ROUND WAVEGUIDE. Yu. M. Aivazyan and D. M. Sedrokyan (Central Scientific-Research Lab. of Physics and Tech., Academy of Sciences, Armenian SSR). Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk, 17: 123-7(1964). (In Russian)

The radiation field produced by a charged particle moving nonuniformly along the axis of a semi-infinite round waveguide is considered. The electric field intensity is calculated in terms of the Hertz vector, equations for which are derived and integrated by the saddle point method. A series is derived for the total radiated power, in which the principal term is the radiation due to uniformly moving particles, and the deviations from the results of uniform motion attenuate exponentially with increasing wave number. (ATD)

23485 DIRAC ELECTRON IN THE FIELD OF PLANE ELECTROMAGNETIC WAVE. I. I. Gol'dman (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz. Mat. Nauk, 17: 129-35(1964). (In Russian)

The Dirac equation is solved for the case of an arbitrary plane electromagnetic wave; the solution is based on the use of projection matrices, and thus leads to appreciable simplifications. A physical analysis is made of the solution, and in particular the electronic and positronic states are separated in the solutions. The orthogonality of the system of solutions is proved, in view of the importance of the solution to the calculation of Compton scattering of intense photon beams. The case of a monochromatic wave is also considered. (ATD)

23486 CLUSTER EXPANSIONS AND THE UNITARY GROUP. Robert Yaris (Washington Univ., St. Louis). J. Chem. Phys., 42: 3019-24(May 1, 1965).

A further discussion of the possibility of product generators was undertaken. It is shown that the unitary group decomposes in a physically plausible way such that the cluster structure appears quite naturally. Through the use of this decomposition it is shown that there are three contributing effects, which determine a cluster function: form, dynamics, and background. These three effects are discussed in the context of the problem of the transferability of cluster functions. (auth)

23487 PROJECTION OPERATORS IN QUANTUM-MECHANICAL PERTURBATION THEORY. W. R. Salzman and M. E. Baur (Univ. of California, Los Angeles). J. Chem. Phys., 42: 3291-8(May 1, 1965).

The construction of operator functionals of the full Hamiltonian of a quantum-mechanical system, which act as projection operators for a specified exact eigenstage, was studied. In general these operator functionals are not equivalent to the formal operator $|\Psi\rangle\langle\Psi|$, where $|\Psi\rangle$ is the state of interest, and are not always idempotent. A formal method by which standard perturbation theoretic expansions for the exact ground-state vector and ground-state energy of the system can be recovered by expansion of a certain operator functional of this type is presented. Related work is briefly discussed. (auth)

23488 SCHROEDINGER'S EQUATION FOR A SYSTEM OF PARTICLES. S. Datta Majumdar and S. Sen Gupta (University Coll. of Science, Calcutta). J. Phys. Soc. Japan, 20: 428-31(Mar. 1965).

A simple and uniform treatment is presented for eliminating the angular variables from the n-particle Schroedinger equation and for deriving the hamiltonian of polyatomic molecules in a form suitable for a perturbation calculation. The hamiltonian is first set up conveniently in a special set of rotating axes. Introduction of three pseudomomenta, which correspond to no coordinates, greatly simplifies the calculation and makes it unnecessary to evaluate the Jacobian of the transformation. The hamiltonian so obtained can be directly used to eliminate the angular variables. For the molecular problem it is found necessary to pass to some other rotating frame in which the coupling between rotation and vibration becomes sufficiently small. A method for doing this is discussed. (auth)

23489 EXISTENCE OF THE SCHRÖDINGER AND HEISENBERG PICTURES. J. M. Simon and J. G. Taylor (Rutgers State Univ., New Brunswick, N. J.). Nature, 205: 1305-6(Mar. 27, 1965).

Using a model formulated by Dirac, it is shown that there is a natural separable Hilbert space on which the Heisenberg and Schroedinger pictures both exist and are equivalent. (D.C.W.)

23490 DOES QUANTUM MECHANICS EXCLUDE LIFE? M. Ageno (Istituto Superiore di Sanita, Rome). Nature, 205: 1306-7(Mar. 27, 1965).

The possibility of a quantum-mechanical description of life is briefly discussed, considering a living organism together with the environment from which it draws its food as a quantum system. The reproduction and sponta-

neous generation of living organisms are considered. (D.C.W.)

23491 UNIFIED RELATIVITY AND QUANTUM THEORY. D. E. Littlewood (University Coll. of North Wales, Bangor). Nature, 205: 1342(Mar. 27, 1965).

A mathematical model is described which reconciles electromagnetism, quantum mechanics, and relativity. The model consists of a five-dimensional space-time with a distribution of spinors which satisfies the fundamental differential equation curl W = 0. (D.C.W.)

23492 CANONICAL FORM OF BOGOLIUBOV TRANSFORMATIONS FOR BOSONS AND THE PSEUDO-ORTHOGONAL TRANSFORMATIONS. R. Balian, C. de Dominicis, and C. Itzykson (CEN, Saclay, France). Nucl. Phys., 67: 609-24(June 1965). (In French)

The real pseudo-orthogonal group of transformations in the space E, the direct sum of subspaces $E_t(t_1...t_m)$ and $E_x(x_1...x_n)$, is considered. These transformations are cast into the canonical form USU′, where U,U′ are orthogonal transformations which do not mix coordinates t_i with x_j, and S is a special Lorentz transformation which operates separately in each (t_ix_i) plane. Some properties of the usual Lorentz group are thereby generalized. A similar decomposition is also obtained for the orthogonal group. Bogoliubov linear canonical transformations for the boson creation and annihilation operators $a_i a_i^\dagger$ are also cast into the same form; U, U′ are not unitary transformations in the single-particle boson space, which do not mix creation and annihilation operators; S only mixes the operators a_i and $a_i^\dagger$ referring to the same state i, in contradistinction with the fermion case. This canonical form is used to discuss two approximations commonly introduced in nuclear physics to solve the so-called RPA equations. (auth)

23493 ROTATING SELF-CONSISTENT FIELDS IN A SOLUBLE MODEL. J. A. Evans (Universidad, Buenos Aires). Nucl. Phys., 68: 86-92(June 1965).

Self-consistent wave functions are constructed in a modified Hartree-Fock approximation for a rotating system consisting of k identical fermions interacting via quadrupole forces in a single harmonic oscillator shell. (auth)

23494 GENERAL GAUGE INVARIANCE OF MASSIVE ELECTRODYNAMICS AND THE EXISTENCE OF A MASSLESS SCALAR PARTICLE. York-Peng Yao (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 138: B698-702(May 10, 1965).

A theory of massive electrodynamics which admits gauge invariance of the second kind is formulated. In so doing, a massless scalar field is needed. However, if the conserved-current condition $\partial_\mu j^\mu = 0$ is satisfied, this scalar field has no dynamical consequences. This theory then reduces to the conventional theory. When the conserved-current condition is not satisfied, a generalized current must still be conserved in order to have consistency of the theory. In an addendum, a brief discussion of the generalized Stueckelberg formulation is given. (auth)

23495 QUANTUM HARD-SPHERE GAS. [PART] I. Marshall Luban (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 138: A1028-32(May 17, 1965).

The problem of finding an operator, defined for all relative distances of two particles, which plays the role of a hamiltonian such that the subsequent eigenvalue problem has as its only solutions precisely the eigenfunctions for two hard spheres, each of core diameter a is considered. This operator is explicitly constructed. Its crucial asoect is that, despite its being defined for all relative distances r_{12}, its eigenfunctions serve as a complete set for expressing a two-particle wave function only in the restricted interval $r_{12} \geq a$. (auth)

23496 QUANTUM HARD-SPHERE GAS. [PART] II. Marshall Luban (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 138: A1033-45(May 17, 1965).

By means of a method which correctly reproduces the scattering of two hard spheres for all relative momenta and all partial waves, the properties of a low-density hard-sphere boson gas at T = 0°K are investigated. The system is described by a hamiltonian $\mathcal{H}$ defined for all relative distances of the N particles. The terms of $\mathcal{H}$ corresponding to the forward motion of a particle through the system lead to the notion of an effective mass M for each particle in excess of its actual mass m, with M/m given by a monotonically increasing function of ρa^3, where ρ and a are the number of particles per unit volume and the hard-sphere diameter, respectively. The excitation spectrum is linear at low momenta, displays a roton-like behavior for momenta $p \gtrsim \hbar/a$, possesses further extrema at higher momenta, and asymptotically approaches $p^2/2M$. The pair distribution function vanishes in the low-density limit for particle separations $r \leq a$. (auth)

23497 NEW INTERPRETATION FOR THE TIME-SPACE STRUCTURE IN THE GRAVITATION FIELD. E. Kuronuma. Soryushiron Kenkyu, 27: 124-42(1963). (In Japanese)

In the interpretation of the time-space structure in the gravitation field, the general relativistic theory is not disregarded but is in coexistence with it. The Newton and Einstein 'S theories of graviation are summarized by means of taking the special relativistic theory as a medium and a deduction for unification between gravitation field and electromagnetic field is also given. Questions concerning the general relativistic theory are pointed out. The coordinates of general relativistic theory are rigorously limited so as to describe its physical meaning. The points of view and fundamental assumptions of the author are also discussed. The deflection of light and the Einstein effect of gravitative shift of spectrum are explained in the region of plane space; and the relation between the natural unit of time-space and the gravitative potential is also obtained. The various of gravitative constant is considered in terms of the requirement for covariance or invariance form of Poisson equation. The element of line in gravitation field of central symmetry is defined with the interior and exterior of matter. Finally the progress of perihelion of orbit for planets is correctly calculated. The general relativistic theory is explained by means of the relation between the absolute and natural units of measure for time-space so as to describe the meaning of curvature of space and its objective reality. (auth)

23498 MEISSNER EFFECT AND SELF-ENERGY OF PHOTON. Hara Gsamu. Soryushiron Kenkyu, 27: 153-6(1963). (In Japanese)

The theory of the Meissner effect in the superconductive theory is applied to resolve the problem of the self-energy of the photon. It is assumed that the self-energy of the photon is produced by the current induced by an external field in a vacuum electron system. The distance between positive and negative energy levels of a vacuum electron field $2mc^2$ is analogous to the finite gap in the electron energy spectra of the superconductor. The induced currents in the Meissner effect and in the self-energy of the photon are obtained. (L.B.S.)

23499 A SUGGESTION FOR THE REVISED FIELD THEORY. K. Ono. Soryushiron Kenkyu, 27: 304-8(1963). (In Japanese)

A suggestion modifying the calculated method is offered on the basis of the point of view that the anti-particle is merely the mirror image of a particle. The images of the production and annihilation of a pair of particles are different from that in the field theory since the particle and its anti-particle were regarded as optical isomers. (L.B.S.)

23500 NOTE ON THE SPIN OPERATOR OF DIRAC ELECTRONS. H. Yamazaki. Soryushiron Kenkyu, 27: 540-5(1963). (In Japanese)

The time variation of the general operator Q containing spin is investigated by means of the study of semi-classical behavior of Dirac electrons. It is pointed out that the advantages of introducing Q are that it may be written in covariant form, and the rules of variation with time may be defined in terms of the covariant hamiltonian when an external field exists. (L.B.S.)

23501 ON THE COMBINATORIES OF FEYNMAN GRAPHS. [PART] II. Ta-chung Meng (Universitat, Frankfurt am Main). Z. Physik, 183: 283-302(1965).

Some of Dyson's conjectures on the combinatories of Feynman graphs especially the following theorem is proved rigorously: the truncated time-ordered Green's functions will be correctly calculated if, in their series expansions, all the reducible graphs are excluded and appropriate insertions in the irreducible ones are made. Along with the lemma presented in I, it leads to a similar theorem for the scattering operator. The model used to demonstrate these properties is a scalar hermitean field with A^4 self-coupling. (auth)

23502 RENORMALIZED FIELD OPERATOR IN THE HEISENBERG REPRESENTATION. A. D. Sukhanov (Karpov Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 538-47(Feb. 1965). (In Russian)

The general methods developed previously are employed for determining the renormalized field operators in the Heisenberg representation. Due to the latter the operators are related to the corresponding field free operators in a nonunitary manner which, in particular, permits one to remove in the scalar case the well known contradiction between the consequences of the Källen-Lehmann theorem and the canonical commutation relations (c.c.r.) for free fields. With aid of a half S-matrix it is found to be possible to introduce the field operators in the interaction representation with which the Heisenberg operators are connected in a unitary way. These operators satisfy the same equations as the free field operators but obey different c.c.r., the difference being especially large for fields which are more complex than the scalar field. The results obtained are serious arguments that the renormalized Heisenberg and free fields should be referred to inequivalent c.c.r representations. The problem of renormalization of the external lines in the S matrix is also considered and a unique method for carrying out the procedure by applying the Wick theorem in the coordinate representation is suggested. (auth)

23503 POLARIZATION OF THE CHARGED VECTOR FIELD VACUUM. V. S. Vanyashin and M. V. Terentev. Zh. Eksperim. i Teor. Fiz., 48: 565-73(Feb. 1965). (In Russian)

Nonlinear additions to the Lagrangian of a constant electromagnetic field, which are caused by the polarization of the charged vector field vacuum, were calculated in the special case of the vector boson gyromagnetic ratio equal to 2. The result is an exact one for an arbitrarily strong electromagnetic field, but it does not take into account the radiative corrections, which can play an essential role in nonrenormalizable vector boson electrodynamics. An anomalous character of the charge renormalization is pointed out. (auth)

23504 FUNCTIONAL INTEGRALS IN QUANTUM ELECTRODYNAMICS AND THE INFRARED ASYMPTOTIC OF THE GREEN FUNCTIONS. B. M. Barbashov (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 48: 607-21(Feb. 1965). (In Russian)

The Green functions for the Klein-Gordon and Dirac equations in an arbitrary external field are written down as a functional integral. It is shown that functional quadratures can be performed for fields admitting an exact solution (stationary field and plane wave field). The form of the solutions thus obtained is such that quantum Green functions can be obtained by the method of functional averaging over the external fields and their asymptotic in the infrared region can be investigated. Corrections to the Bloch-Nordsieck formula are found for a simple field theory model. (auth)

23505 ON FIELD THEORY WITH NONLOCAL INTERACTION. IV. CONVERGENCE, CAUSALITY AND GAUGE INVARIANCE PROBLEMS. A. N. Leznov and D. A. Kirzhnits (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 622-31(Feb. 1965). (In Russian)

A simple method is presented for setting up a relativistically invariant, unitary, and divergence-free nonlocal field theory which is causal as long as the kinematic invariants of the problem do not exceed a certain limiting value. A nonlocal electrodynamics is developed which also satisfies the gauge invariance conditions. Some problems concerning the description of macroscopic bodies and introduction of additional vectors into the interaction are discussed. (auth)

23506 INFRARED SINGULARITIES IN LOCAL FIELD THEORY. L. D. Solovev (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 48: 731-41 (Feb. 1965). (In Russian)

The first term and an estimation of the following term in the Green function expansion for a charged particle in the infrared region are obtained in the local field in which quantum electrodynamics in all orders of e is included. A similar expansion is obtained for the Compton scattering amplitude with a fixed value of the transferred momentum. The method is based on application of the dispersion relations and expansions of the current matrix elements in the soft photon momenta. (auth)

23507 THE GREEN FUNCTION METHOD IN STATISTICAL MECHANICS. V. L. Bonch-Bruevich and S. V. Tyablikov. Translated from the Russian and edited by D. Ter Haar. Amsterdam, North-Holland Publishing Company and New York, Interscience Publishers, Inc., 1962. 260p.

The quantum-mechanical Green-function method for solving many-body problems is presented. The general spectral theory of the nonrelativistic temperature-dependent Green functions depending on two-time arguments is developed, and the connection between the Green functions and the thermodynamic and kinetic characteristics of a system is established. The method is illustrated by application to various problems in the physics of condensed media: the theory of electron plasmas in solids, charge carriers in solids and semiconductivity, electron-phonon interactions, and ferromagnetism at finite temperatures. 266 references. (M.J.T.)

Geophysics

Refer also to abstracts 23837 and 23946.

23508 (AD-603532) STUDY AND EXPERIMENTAL WORK ON ATOMIC COLLISION PROCESSES OCCURRING IN ATMOSPHERIC GASES. Technical Progress Letter 39, April 1–June 30, 1964. A. V. Phelps (Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.). June 30, 1964. Contract AF29(601)-6271. 5p. $1.00(CFSTI).

Research progress in the following fields is summarized: electron-positive ion recombination; electron attachment in O_2 and O_2-H_2O mixtures; and attachment and detachment in $O-O_2$ mixtures. (auth)

23509 (AD-606701) DIURNAL VARIATION OF IONOSPHERIC ELECTRON CONTENT OBTAINED FROM DOPPLER SLOPES OF SIMULTANEOUS SATELLITE SIGNALS. Technical Report 2489. P. R. Arendt and H. Soicher (Army Electronics Labs., Fort Monmouth, N. J.). July 1964. 44p. $2.00(CFSTI).

All Doppler methods for measuring the electron content using simultaneously emitted rocket or satellite cw signals of different frequencies are based on the assumption that those signals travel towards the observer along nearly identical paths. Measurement of Doppler slopes of high elevation orbits at the points of inflection are analyzed. The comparison of the observed time moments at which Doppler inflection of different frequencies occurs provides a means of selecting only those data that are actually simultaneous. Data selected in accordance with this principle can be evaluated on the basis of straight-line propagation. The actual data describe the diurnal variation of the integrated electron density during November and December, 1961. Attention is focused on an apparent enhancement of the content about midnight. This enhancement is considered to be indicative of vertical downward electron transport. (auth)

23510 (AFCRL-64-1021) DIRECT SATELLITE PROBE MEASUREMENTS OF IONOSPHERIC IRREGU-

LARITIES IN THE F REGION AND THE POLAR CAP. Environmental Research Paper No. 74. J. C. Ulwick, W. Pfister, and R. E. McInerney (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Dec. 1964. 22p.

A standing-wave impedance probe has been flown on polar orbiting satellites through the F_2 layer. Continuous measurements for entire orbits were recorded and stored on magnetic tape. The data were processed and plotted completely automatically from the telemetry magnetic tapes. In studying the profiles through the F region, irregularities are found, superimposed on the gross features of the ionosphere. Irregularities of a size in the order of 400 kilometers are noted, with small-scale density fluctuations between 5 and 10 percent. There is a tendency of these irregularities to be larger in the vicinity of the magnetic equator. Of special interest are irregular structure observed in the south polar region above the peak of the F layer. The satellite passes through the region at the same local time but covers the whole region geographically in the course of a day. One system of irregularities appears to be aligned with the magnetic latitude, while another structure appears consistently at a geographic latitude near 70°. (auth)

23511 THE SPACECRAFT RADIATION EXPERIMENTS. W. L. Brown, T. M. Buck, L. V. Medford, E. W. Thomas, H. K. Gummel, G. L. Miller, and F. M. Smits (Bell Telephone Labs., Inc., Murray Hill, N. Y.). Bell System Tech. J., 42: 899-941(July 1963).

Radiation experiments on the Telstar spacecraft were designed to measure the distribution in energy, position, and time of electrons and protons geomagnetically trapped in the Van Allen belts, thus characterizing the radiation environment of the satellite and providing an understanding of mechanisms responsible for particle injection into, and loss from, the belts. Some experiments also measured directly the integral radiation damage on semiconductors protected by different thicknesses of shielding. An experiment measuring the orientation of the satellite with respect to the sun is also included. A correspondence was established between the radiation damage in the solar-cell power supply, the solar cells and transistors of the radiation experiment, and the distribution of particles responsible for the damage. All parts of the experiment performed as expected, and the particle detectors, continuing satisfactory operation after several months in space. (M.J.T.)

23512 RESULTS OF THE TELSTAR RADIATION EXPERIMENTS. W. L. Brown, J. D. Gabbe, and W. Rosenzweig (Bell Telephone Labs., Inc., Murray Hill, N. J.). Bell System Tech. J., 42: 1505-9(July 1963).

Results are given of the Telstar experiments measuring energy, time, and space distributions of electrons and protons, using Si p-n junction detectors, and of the integral radiation exposure of the satellite calculated from these distributions. Connections of the charged-particle distributions with nuclear explosions are discussed. Radiation damage to the semiconductor detectors, the solar power plant, and solar cells and damage transistors is reported and compared with that predicted on the basis of orbital integral radiation exposures. (M.J.T.)

23513 SOME OBSERVATIONS OF TYPE-B RED AURORA WITH A MULTICHANNEL PHOTOMETER. W. F. J. Evans and A. Vallance Jones (Univ. of Saskatchewan, Saskatoon). Can. J. Phys., 43: 697-704(Apr. 1965).

A five-channel interference filter photometer was used to make observations of the relative brightnesses of the first positive group N_2 bands, the λ-3 914 N_2^+ band, the λ-5 577 [OI] line, and the first negative O_2^+ bands in type-B red aurora. It was found that the time delay between the emission of the 1NG N_2^+ bands and the 1PG N_2 bands was less than 0.1 sec in disagreement with the O_2^-/N_2^+ charge neutralization mechanism for the enhancement of the first positive group bands. The lifetime of the $O(^1S)$ atoms emitting the green line was determined by the method of Omholt by comparing fluctuations in the emission of the green line with those of the N_2^+ bands. In type-B red aurora it was found that this lifetime corresponded to 0.48 ± 0.06 sec as compared with 0.67 ± 0.06 sec in normal aurora. This may indicate that collisional deactivation of the $O(^1S)$ state occurs in type-B red aurora and is one factor contributing to the reddening. The relative brightness measurements showed, for type-B red aurora compared with normal aurora, an appreciable intensification (~50%) of the 1PG emission compared to the 1NG N_2^+ bands. At the same time there was observed an average decrease of about 30% in the intensity of the green line compared to the 1NG bands. (auth)

23514 A SURVEY OF ELECTRONS E > 40 kev BEYOND 5 EARTH RADII WITH EXPLORER 14. L. A. Frank (Univ. of Iowa, Iowa City). J. Geophys. Res., 70: 1593-1626(Apr. 1, 1965).

A survey of the spatial distribution of electrons E > 40 kev beyond ~R_E (earth radii) using ten months of Explorer-14 observations revealed that the gross features of the distribution are (1) a hard core of intensities of ~10^7 $(cm^2\ sec)^{-1}$ extending from ~2 to 8 R_E near the magnetic equatorial plane, which is characterized by small temporal variations compared with those at larger radial distances, and a weak latitude dependence; (2) a tail of electron fluxes on tne night side of the earth confined near the ecliptic plane behond ~10 R_E; (3) an increasing radial extent of intensities ≥10^5 $(cm^2\ sec)^{-1}$ as the local time of the satellite position increases (decreases) from local noon (~11 R_E) to evening (morning) (≳16 R_E); and (4) high intensities at all latitudes of the Explorer-14 trajectory in the day side of the magnetosphere to ~11 R_E and a relative sparsity of electrons in the night side of the magnetosphere beyond ~8 R_E at high ecliptic latitudes. The B and L coordinates are shown to lose their effectiveness for organizing the observed omnidirectional intensities beyond ~6 R_E; the observations of electrons E > 40 kev beyond ~10 R_E in the tail of the magnetosphere can be conveniently summarized in an earth-centered solar-ecliptic coordinate system. Magnetic meridian summaries of the measurements of electrons E > 40 kev for a variety of local times offer a detailed view of the spatial distributions and temporal variations of the electron intensities throughout the magnetosphere. Acceleration of electrons E > 40 kev within ~2 or 3 R_E beyond the sunward side of the magnetospheric boundary is suggested by recurrent spikes of intensities. Sample three-point integral energy spectra of electrons (over the energy range 40 kev to 1.6 Mev) are presented for a typical pass of Explorer 14 through the earth's magnetosphere. It was found that the electron spectrum softens with increasing geocentric radial distance. The observation of catastrophic variations of electron intensities deep within the magnetosphere at L ≈ 5 ($\lambda_m \approx 30°$) on December 20-21, 1962, implies a strong source and loss mechanism effective throughout a major part of the earth's magnetosphere. (auth)

23515 EVIDENCE FOR RAPID MOTION OF THE OUTER BOUNDARY OF THE MAGNETOSPHERE. Andrei Konradi (Goddard Space Flight Center, Greenbelt, Md.) and Richard L. Kaufmann. J. Geophys. Res., 70: 1627-37 (Apr. 1, 1965).

A sudden increase of the particle intensity and of the magnetic field strength on September 25, 1961, at 1731 UT was detected by the ion-electron detector and the magnetometer on Explorer 12 outside the earth's magnetosphere. Comparison of the cyclotron radii of the trapped protons with the distance through which the satellite traveled showed the event to be temporal rather than spatial. Similarities between particle fluxes as well as between magnetic fields during the increase and within the outer belt make it probable that the increase represents an impulse-like extension of at least a part of the outer belt. A deduced lower limit on the outward radial velocity of the extension is 156 km/sec. Crude calculations show that either the proton density near the outer edge is less than 100 cm^{-3} or the temperature is greater than 15 ev. (auth)

23516 ION COMPOSITION AND TEMPERATURES AT 1000 km AS DEDUCED FROM SIMULTANEOUS OBSERVATIONS OF A VLF PLASMA RESONANCE AND TOPSIDE SOUNDING DATA FROM THE ALOUETTE 1 SATELLITE.

R. E. Barrington, J. S. Belrose, and G. L. Nelms (Defence Research Telecommunications Establishment, Ottawa). J. Geophys. Res., 70: 1647-64(Apr. 1, 1965).

Evidence is presented to support the hypothesis that the low-frequency cutoff of a vlf noise band observed by Alouette 1 is due to a plasma resonance (the lower hybrid resonance) which defines a cutoff frequency for propagation transverse to the earth's field. If this hypothesis is accepted, the observations of this cutoff frequency by the satellite's vlf receiver and simultaneous measurements of the electron plasma frequency by the topside sounder can be used to determine an effective mean mass $\overline{m}_i$(eff) for the ions in the ambient plasma. The $\overline{m}_i$(eff) values, together with the scale height measured from the electron density profiles, set limits on the ion composition and temperature. The main support for the hybrid resonance hypothesis lies in the plausibility of the temperature and ion mass information that is derived using this interpretation and the agreement between this information and the results of other workers. In general, $\overline{m}_i$(eff) is found to be larger during the day than at night and to increase with latitude. In polar regions $\overline{m}_i$(eff) ranges from about 7 at midnight to about 13 at noon; at midnight the composition of the polar ionosphere at 1000 km is more than 60% O^+, whereas at noon it is about 95% O^+. At middle latitudes, L = 2 to 3, $\overline{m}$ (eff) ranges from 1.8 to as high as 7. For low latitudes, L < 2, the lowest observed values of $\overline{m}_i$(eff) of 1.3 require that the H^+ concentration be greater than 68%. An effective ionospheric temperature of about 1200°K is determined for middle latitudes, increasing to high values for high latitudes. A marked diurnal variation of temperature is found at high latitudes. (auth)

23517 ION CYCLOTRON WHISTLERS. D. A. Gurnett (Univ. of Iowa, Iowa City), S. D. Shawhan, N. M. Brice, and R. L. Smith. J. Geophys. Res., 70: 1665-88(Apr. 1, 1965).

Results of an experimental study of the proton whistler, a vlf phenomenon observed in satellite data, are presented, and an explanation of this effect is given. The proton whistler appears on a frequency-time spectrogram as a tone which starts immediately after the reception of a short fractional-hop whistler at the satellite and initially shows a rapid rise in frequency, asymptotically approaching the gyrofrequency for protons in the plasma surrounding the satellite. It is proposed that the proton whistler is simply a dispersed form of the original lightning impulse and that the dispersion can be explained by considering the effect of ions on the propagation of an electromagnetic wave in the ionosphere. The propagation of a wave in a multicomponent plasma for frequencies of the order of ion gyrofrequencies is discussed. In the ionosphere it is found that, in addition to the right-hand polarized whistler mode, the left-hand polarized mode (ion cyclotron wave) is also a possible mode of propagation for certain ranges of frequencies and altitudes. Between each two adjacent ion gyrofrequencies there is a frequency for which both modes of propagation are linearly polarized, called the crossover frequencies. A wave propagating in the ionosphere changes polarization at the altitude where the wave frequency is equal to a crossover frequency. This polarization reversal provides the mechanism by which an upgoing whistler can become an ion cyclotron wave. It is shown that the proton whistler is an ion cyclotron wave which occurs via this polarization reversal process. The crossover frequency can be measured from spectrograms of proton whistlers and is used to determine the fractional concentration of H^+ in the plasma surrounding the satellite. Near the altitude and frequencies for which polarization reversal occurs, it is shown that the right-hand polarized wave and the ion cyclotron wave may be strongly coupled. For frequencies of the order of the ion gyrofrequencies this coupling process plays an important part in determining what regions of the ionosphere are accessible to waves from a given source location. (auth)

23518 STABLE AURORAL RED ARCS, SINKS FOR ENERGY OF D_{st} MAIN PHASE. K. D. Cole (Univ. of Chicago). J. Geophys. Res., 70: 1689-1706(Apr. 1, 1965).

A new source of energy for the ionosphere during geomagnetic storms is discussed. Stable auroral red arcs, together with the atmosphere in their vicinity, constitute a major sink of energy for the D_{st} main phase of a magnetic storm. The intensity of the red arc, the electron density in the F region, the inferred temperature of electrons in the arc, the inferred transfer of energy from electrons and ions to neutral particles in the region, and the uninhibited decay rate of D_{st} main phase energy are found to be mutually consistent. Energetic trapped particles causing a major part of the D_{st} main phase are degraded in energy by Coulomb collisions with a background magnetospheric thermalized plasma of temperature about 10,000°K. The temperature of F-region electrons (about 3200°K in a 100 γ storm), sufficient to excite the arc, is maintained by heat conduction from the magnetosphere along the lines of force. Conduction in the electron-ion gas proceeds downward to a transition level where transfer of heat to neutrals absorbs the heat flux. Below this height, conduction in the neutrals dominates. This source of heat causes the temperature of the neutral particles in the arc to rise by amounts of the order of 100°K in a 100 γ storm. Most of the reported properties of the arc are consistent with the theory. A coherent theory is provided of (1) the main-phase decrease of the surface geomagnetic field during storms, (2) the depletion of ionization in the outer magnetosphere during storms, (3) the stable auroral red arc, and (4) D_{st} variations of the F region at mid-latitudes. (auth)

23519 OBSERVATIONS ON THE SPATIAL STRUCTURE OF PULSATING ELECTRON PRECIPITATION ACCOMPANYING LOW-FREQUENCY HYDROMAGNETIC DISTURBANCES IN THE AURORAL ZONE. J. R. Barcus and T. J. Rosenberg (Univ. of California, Berkeley). J. Geophys. Res., 70: 1707-16(Apr. 1, 1965).

Low-frequency hydromagnetic disturbances generated in the sunlit part of the distant magnetosphere and propagating as transverse waves to auroral latitudes are accompanied by pulsating electron precipitation and ionospheric absorption of cosmic radio noise with a similar temporal behavior. The region over which this pulsating activity occurs is belt-like, $\gtrsim$1000 km long and ~100-400 km across. Sometimes the instantaneous pattern of precipitation exhibits spatial structure over these dimensions, but at least on one occasion the pulsations were in phase over a large region near the noon meridian. A unique acceleration process does not appear to be required, as the bremsstrahlung x-ray spectra obtained for the pulsations are not essentially different from those observed during activity preceding or following these events. The statically trapped radiation is eliminated as a possible source, and some mechanisms involving local energization are briefly discussed. (auth)

23520 PARTICLE TRAJECTORIES IN A MODEL CURRENT SHEET, BASED ON THE OPEN MODEL OF THE MAGNETOSPHERE, WITH APPLICATIONS TO AURORAL PARTICLES. T. W. Speiser (Pennsylvania State Univ., University Park). J. Geophys. Res., 70: 1717-28(Apr. 1, 1965).

A study is presented of charged particle trajectories about a current sheet based on Dungey's open model of the magnetosphere. The object is to see whether charged particles incident on this model current sheet from the solar wind and emerging as possible auroral particles emerge in complex spatial distributions resembling auroral forms. Adiabatic theory breaks down near a neutral point in the current sheet, and particle trajectories must therefore be computed. The computation is done on an IBM 7074 computer. Only proton trajectories are studied extensively, and the results yield accelerated output protons with high intensity in a thin sheet, with perhaps some thin beam structure within the sheet. Such a production of thin sheets or beams of accelerated particles is necessary for an auroral theory. The energy of the output protons is 900 times the energy of the particles comprising the bulk flow, but this energy is still about an order of magnitude smaller than that observed for auroral protons. Preliminary results with a few electron trajectories indicate that the model should yield electron energies of about the right order of magnitude for auroral electrons. Furthermore, a structure for the output electrons thinner than that for protons is suggested by these preliminary results. (auth)

23521 EFFECTIVE RECOMBINATION COEFFICIENTS IN THE LOWER IONOSPHERE. R. C. Whitten (Stanford Research Inst., Menlo Park, Calif.), I. G. Poppoff, R. S. Edmonds, and W. W. Berning. J. Geophys. Res., 70: 1737-42(Apr. 1, 1965).

Simultaneous measurements of ionizing radiation and electron density during the 1962 nuclear tests yield a profile of the effective recombination coefficient. This can be interpreted in terms of dissociative and ion-ion recombination, electron attachment, and no detachment. Values of the dissociative and ion-ion recombination coefficients are obtained. (auth)

23522 RELATIONS BETWEEN THE MAGNETIC DISTURBANCES OBSERVED BY Imp 1 SATTELLITE AND TERRESTRIAL MAGNETIC MICROPULSATIONS. Yoshio Kato (Tohoku Univ., Sendai, Japan). J. Geophys. Res., 70: 1754-7(Apr. 1, 1965).

Magnetic disturbances observed by the Imp satellite and geomagnetic micropulsations observed simultaneously at the Onagawa Magnetic Observatory, Japan, and the Wingst Magnetic Observatory, Germany, are compared and discussed, for the sudden commencement on Dec. 2 and the sudden impulse on Dec. 1, 1963. (M.J.T.)

23523 WIND-INDUCED MAGNETIC FLUCTUATIONS. C. O. Hines (Univ. of Chicago). J. Geophys. Res., 70: 1758-61(Apr. 1, 1965).

Residual magnetic fluctuations of amplitude about 3 to 6 γ, appearing on most quiet days even at middle latitudes, are studied. The possibility that a distinct source other than the solar wind is operative at this low intensity level, providing a natural background into which solar-wind induced fluctuations may subside, is considered. This source is provided by the irregular winds of the ionospheric dynamo region. Testing of this hypothesis, using measurements on rocket-released vapor trails, is discussed, considering polarization fields and irregularities of the winds. (M.J.T.)

23524 RADIOACTIVITY INDUCED IN SODIUM IODIDE BY TRAPPED PROTONS. Laurence E. Peterson (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 70: 1762-5(Apr. 1, 1965).

A report is given of the radioactivity induced in the NaI crystals of the scintillation counter on the satellite Oso 1, during the brief periods when it passed through the lower edge of the inner Van Allen zone over the South Atlantic region. Results are presented of counting rates in the radiation zone, for cosmic-ray background outside the zone, and of background plus induced activity just after leaving the zone. Measurements indicate that the induced activity is due to beta decay of ^{128}I, formed in the counter when ^{127}I captures neutrons produced by the trapped protons in the radiation belt. (M.J.T.)

23525 MEASUREMENT OF SOFT-ELECTRON FLUXES IN THE UPPER ATMOSPHERE BY MEANS OF A SECONDARY-ELECTRON MULTIPLIER. L. A. Antonova, G. S. Ivanov-Kholodnyi, N. D. Masanova, and V. S. Medvedev. Kosmich. Issled., 3: 82-8(Jan.-Feb. 1965). (In Russian)

A rocket experiment for recording soft (100 to 10,000 ev) electrons at altitudes from 180 to 500 km outside the region of polar lights is described. The experiment, carried out on 18 October 1962 in the middle latitudes of the European USSR at a solar elevation of 12°45′, was for the purpose of testing a new method of measuring corpuscular radiation. The measuring instrument had as its main element an open-type secondary-electron multiplier installed in the new SF-type corpuscular-radiation recorder. Two protective rings at a potential difference of +12 and −12 v were placed before the input orifice to exclude the charged particles of the ionosphere. The multiplier was evacuated to about 10^{-5} mm Hg before the launch. The time resolution of the system in two frequency ranges was 50 to 100 μsec; the time constant 5×10^7 cm^{-2} sec^{-1} sterad^{-1} and did not depend on the angle with the plane perpendicular to the magnetic force line within the limits of ±30°. Other filters yielded useful signals which were used to plot an energy spectrum of the flux. (ATD)

23526 ROLE OF PLASMA INSTABILITIES IN AURORAL PHENOMENA. Bruno Coppi (Stanford Univ., Calif.). Nature, 205: 998(Mar. 6, 1965).

In discussing the role of plasma instabilities in auroral phenomena, it is proposed that the instability excited plasma waves and then accelerates particles according to a pattern of the type considered by Stix, Report MATT-219 (Princeton Univ., 1964), in order to avoid having to consider the trapping and dumping phase. Two classes of microscopic collisionless instabilities that have been investigated are discussed. (P.C.H.)

23527 VLF OBSERVATIONS AT COLLEGE, ALASKA, OF VARIOUS D-REGION DISTURBANCE PHENOMENA. P. R. Albee and H. F. Bates (Univ. of Alaska, College). Planetary Space Sci., 13: 175-206(Mar. 1965).

Between late 1961 and mid-1964 several stabilized vlf transmitters were monitored at College, Alaska. During that period 1846 optically detected solar flares were observed when the NBA recorder was operating and the path was completely sunlit. Of these, 66 produced phase anomalies on the NBA records. The probability of occurrence increased approximately linearly with flare area, but was less than probabilities for SID's determined by other methods. This indicates the vlf phase is not as sensitive as other SID indicators. The SPA decay was very nearly exponential on the College signals. The decay was significantly faster at 10.2 kc/s than at 20 kc/s frequencies. Polar cap precipitation events disrupt polar vlf propagation. The polar D-region was depressed significantly for periods of up to four or five days after relatively minor PCA events. Immediately after three events the phase from GBR was advanced 180 to 270 degrees beyond normal daytime values. The vlf phase anomalies produced by the U. S. and U.S.S.R. high altitude nuclear explosions in 1962, the 20 July 1963 solar eclipse, and the 1 October 1961, subauroral-latitude particle precipitation event are shown and discussed. (auth)

23528 VARIATIONS IN ENERGY SPECTRUM OF AURORAL ELECTRONS DETECTED BY SIMULTANEOUS OBSERVATION WITH PHOTOMETER AND RIOMETER. O. E. Johansen (Norwegian Inst. of Cosmic Physics, Oslo and Norwegian Defence Research Establishment, Kjeller, Norway). Planetary Space Sci., 13: 225-35(Mar. 1965).

Because auroral luminosity and auroral absorption are produced mainly by electrons with different energy, simultaneous observation with photometer and riometer can give information about the energy spectrum of the incident electrons, and in particular be used to detect variations in this spectrum. Limited to cases with homogeneous auroral forms covering most of the sky, observations at 5577 Å and 27.6 MHz show that the energy spectrum can remain constant for long periods, from half an hour to several hours and whole nights. Large and rapid variations do however occur, but less frequently than one could expect from satellite observations. This indicates that many variations in electron energy spectrum observed by satellite-borne instruments are variations in space rather than variations in time. An average over three winters shows a diurnal variation in the energy spectrum with a hardening in the spectral shape between 20 and 01 local time. An unexpected high and variable light intensity corresponding to zero riometer absorption is also discussed. (auth)

23529 THE GEOMAGNETIC TAIL AND MAGNETIC STORM THEORY. J. H. Piddington (Commonwealth Scientific and Industrial Research Organization, Sydney). Planetary Space Sci., 13: 281-4(Apr. 1965).

The hypothesis of a frictional interaction between the solar wind and the magnetosphere is briefly discussed, particularly its significance in connection with a magnetospheric tail and a hydromagnetic theory of geomagnetic storms. (D.C.W.)

23530 THE DEVELOPMENT OF GEOMAGNETIC STORMS WITHOUT A PRECEDING ENHANCEMENT OF THE SOLAR PLASMA PRESSURE. Syun-ichi Akasofu (Univ. of Alaska, College). Planetary Space Sci., 13: 297-301(Apr. 1965).

A considerable geomagnetic storm can develop without

a significant enhancement of the solar plasma pressure which is usually manifested by the storm's sudden commencement. Characteristics of such a storm (the so-called S_g storm) and their implications are discussed. (auth)

23531 MAGNETIC CONJUGACY AT VERY HIGH LATITUDE: SHEPHERD BAY-SCOTT BASE RELATIONSHIP. E. M. Wescott and K. B. Mather (Univ. of Alaska, College). Planetary Space Sci., 13: 303-24(Apr. 1965).

Magnetic variations occurring at very high latitudes were studied to determine if they are similar at conjugate points, how the conjugacy or non-conjugacy changes during the day and season, and how this may be related to the sources of the disturbances and the field lines in the magnetosphere. Data from the conjugate pair Scott Base, Antarctica and Shepherd Bay, Canada were used. Two basic types of magnetic activity must be considered, occurring at about the times the midpoint of the field line linking the pair is at the noon and midnight meridian. The field-line midnight activity seems to result from auroral zone electrojets, and its conjugacy or non-conjugacy relates to the relative locations of the stations to the respective auroral zones. Field-line noon activity is evident even on very quiet K_p days and usually amounts to several hundred gammas irregular variations. It seems likely that this "dayside agitation" relates closely to the neutral point field lines, or on the magnetosphere surface under the solar wind may transmit particle fluxes or hydromagnetic waves down the field lines on the day side. Both the dayside and nighttime types of activity show poor correlation at the conjugate points. Intervals of essentially one-to-one correlation can be found at almost any time during various days however. On the average the best correlation corresponds to the interval following the auroral zone type activity but preceding the dayside agitation. This also corresponds to the average quietest time of the day. These variations may be of global character, reflecting changes in solar wind pressure or interplanetary magnetic fields. (auth)

23532 FREE ELECTRON BALANCE DURING POLAR CAP ABSORPTION EVENTS. L. R. Megill and J. B. Hasted (London Univ.). Planetary Space Sci., 13: 339-43(Apr. 1965).

A proposal that in polar cap absorption events electrons are detached from O_2^- by $O_2(^1\Delta_g)$ is studied. A rate of 10^{-9} cm^3 sec^{-1} is suggested on the basis of microwave studies of the oxygen afterglow; the temporal behavior during sunlight hours is explained without the need for invoking another negative ion. It is suggested that the requirement for a large deactivation rate by ground state O_2, which is in contradiction with experiment, is not required if moderate concentrations of metastable molecules are postulated at night. (auth)

23533 INVESTIGATION OF THE VAN ALLEN BELTS IN THE REGION OF THE BRAZILIAN MAGNETIC ANOMALY AT ALTITUDES OF 235-345 km. S. N. Vernov, V. E. Nesterov, N. F. Pisarenko, I. A. Savenko, O. I. Savun, P. I. Shavrin, and K. N. Sharvina. Planetary Space Sci., 13: 347-51(Apr. 1965).

Translated from Kosmich. Issled., 2: 492(1964).

The results are reported of an investigation of the Van Allen belts in the region of the Brazilian magnetic anomaly by Geiger and scintillation counters in the satellites Kosmos 4, Kosmos 7, Kosmos 9 and Kosmos 15. A comparison is made between the results obtained in these satellites and the second space vehicle. (auth)

23534 INTERPRETATION OF PIONEER-I MAGNETIC-FIELD MEASUREMENTS. M. A. Gintzburg (Inst. of Terrestrial Magnetism, Moscow). Phys. Rev. Letters, 14: 625-6(Apr. 19, 1965).

The pulse structure of the magnetic field in the transition region (12 to 14 R_e), which was continuously measured by the magnetometer of Pioneer-1, is explained in terms of oblique solitary waves (osw). Magnetic-field profiles of two osw are shown along with theoretical curves for the plasma density and electron transverse energy. It is suggested that the osw is the mechanism of transferring the energy and the impulse of translatory movement of corpuscular stream ions to the electrons, and from the electrons to the cold earth plasma. It is also hypothesized that osw can be generated not only by collision of plasma streams, but by the interaction of the stream and its magnetic field with the geomagnetic field. (L.B.S.)

23535 OFFSET VOLTAGES OF LANGMUIR PROBES IN THE IONOSPHERE. Richard T. Bettinger (Univ. of Maryland, College Park). Rev. Sci. Instr., 36: 630-4(May 1965).

Bipolar Langmuir probes display a voltage offset in their volt-ampere characteristics when immersed in the ionospheric plasma. The dependence of the equilibrium potential as a function of probe scale, ambient charge density, and high-energy tail in the electron energy distribution is examined. It is concluded that the offset arises from geometric considerations and is strongly influenced by all of the above factors. The observed altitude dependence is qualitatively explained in terms of vehicle velocity and precessional motion. (auth)

23536 AURORAL PHENOMENA. B. J. O'Brien (Rice Univ., Houston, Tex.). Science, 148: 449-60(Apr. 23, 1965).

Causal relations in auroral phenomena are discussed in detail. The array of auroral phenomena involves all the basic types of physical phenomena: heat, light, sound, electricity and magnetism, atomic physics, and plasma physics. (P.C.H.)

23537 EARLY HISTORY OF THE SOLAR AND INTERPLANETARY MAGNETIC FIELD. G. W. Pneuman (General Motors Corp., Santa Barbara, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-122, 21p, $1.00. (CONF-650108-4)

From AIAA 2nd Aerospace Sciences Meeting, New York.

A theory for deriving the solar and interplanetary magnetic field from the ambient field believed to exist in our galaxy is described. During the condensation of interstellar gas and dust, the original magnetic field is amplified due to the relatively high degree of ionization provided by galactic starlight, cosmic rays, and natural radioactivity. As the density increases, however, a point is reached when, first, external radiation and then cosmic rays cannot penetrate the cloud. At this time the magnetic field decays to the galactic level to be refrozen later when the dust grains evaporate. The subsequent evolution of the magnetic field is studied and its predicted final magnitude and geometry are discussed. The results are found to compare not unfavorably with observation. The later part of the work considers some aspects of the interplanetary field. In particular, the question as to whether the field lines far away from the solar surface close in the form of loops or diverge eventually linking up with the galactic field is studied. (auth)

23538 THE MAGNETOGASDYNAMIC BOUNDARY CONDITION FOR A SELF-CONSISTENT SOLUTION TO THE CLOSED MAGNETOPAUSE. Murray Dryer and Rolf Faye-Petersen (Martin Co., Denver). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-121, 33p, $1.00. (CONF-650108-5)

From AIAA 2nd Aerospace Sciences Meeting, New York.

The conventional numerical blunt body problem is used as an analog for the problem of the solar plasma flow around the geomagnetic cavity. The approach of Spreiter and Jones is extended (using the identical solution of Inouye and Lomax) for an assumed teardrop magnetospheric boundary. After the bulk flow properties are defined, the simplest case of a radial interplanetary magnetic field as suggested by Lees is considered together with a quiet Alfvén Mach number in order to find a first-order approximation to the exact magnetic field configuration for an infinitely conducting neutral plasma. The sum of both gasdynamic and magnetic pressures along the assumed boundary is then proposed as a necessary first step in a self-consistent iterative solution of the inner and outer time-independent magnetospheric problem. Exact post shock magnetic magnitudes and directions are compared

with the first-order solution when the analog-derived shock is assumed to be the exact fast magnetogasdynamic shock wave. This comparison, together with an examination of several typical longitudinal invariant surfaces, indicates the validity of the approximate solution. An example of the three-dimensional magnetic field configuration is then considered for the case when the interplanetary field is perpendicular to the solar wind direction. (auth)

Low Temperature Physics

Refer also to abstracts 22474, 23232, and 23507.

23539 (CEA-R-2616) ETUDE DES SUPRACONDUCTEURS DE LA DEUXIEME ESPECE DU SYSTEME PLOMB–THALLIUM. (Study of Superconductors of the Second Type in the Lead–Thallium System). Gilbert Bon Mardion (Commissariat à l'Énergie Atomique, Grenoble (France). Centre d'Études Nucléaires). Feb. 1965. 77p. Dep.(mn).

It is shown by magnetization measurements on Pb–Tl alloys having 5 to 70 atom per cent thallium, that superconductors of the second type definitely exist. The results obtained, in particular on the upper critical field H_{c2}, agree with the models of Ginzburg, Landau, Abrikosov, Gorkov and Goodman. Resistivity measurements confirm the occurrence of a fourth upper critical field, the existence of which has been theoretically predicted. (auth)

23540 (JPL-TR-32-650(Pt.I)) THE ROTATING SUPERCONDUCTOR. PART I. THE FLUXOID. M. M. Saffren (Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena). Mar. 15, 1965. Contract NAS 7-100. 10p.

The magnetic field present in the bore of a hollow, rotating superconducting cylinder is deduced from London's theory of superconductivity. For a cylinder whose transverse dimensions are larger than a penetration depth, the results show that the quantity $\omega_L + \omega$ is a constant. Here, ω_L is the angular Larmor frequency of the electron, proportional to the field in the bore; ω is the angular velocity of the cylinder itself. The constant is the value of $\omega_L + \omega$ at the time the superconductor becomes superconducting. A nucleation model of the superconducting transition is used to deduce this relation. The Meissner effect in rotating superconductors is discussed, and it is pointed out how the effects of an applied field on a superconductor tend to be cancelled by its rotation. It is pointed out that this cancellation may be important for observing superconductivity in superconductors having tiny critical fields. (auth)

23541 MEASUREMENTS ON NIOBIUM–TIN SAMPLES IN 200-kg CONTINUOUS FIELDS. D. Bruce Montgomery (Massachusetts Inst. of Tech., Cambridge) and William Sampson. Appl. Phys. Letters, 6: 108-11(Mar. 15, 1965).

The critical current density in several samples of Nb-Sn was measured as a function of applied magnetic field at 4.2°K in d-c fields as high as 201 kgauss. The upper critical fields and transition temperatures were determined. (D.C.W.)

23542 SOME PHONON EFFECTS IN SUPERCONDUCTING TUNNEL JUNCTIONS. J. G. Adler, J. S. Rogers, and S. B. Woods (Univ. of Alberta, Edmonton). Can. J. Phys., 43: 557-62(Apr. 1965).

Tunneling measurements were made on junctions consisting of aluminium separated from a second metal by aluminium oxide insulating layers. When the second metal was lead, tin, or indium, the effect of its phonon spectrum on the tunnel current was observed. Results with indium indicated that there is a broad group of phonons at an energy of 5 millivolts and another group at an energy of 13 mv. in the indium phonon spectrum. The end point of the spectrum is at 14.8 ± 0.1 mv. Evidence is presented for a relation between the strength of the phonon structure, the phonon energy, and the width of the superconducting energy gap from measurements on lead, tin, and indium. Measurements of the temperature dependence of the phonon structure in lead and indium are also reported. (auth)

23543 A STUDY OF SUPERCONDUCTIVITY IN LEAD-BISMUTH ALLOYS USING ELECTRON TUNNELING TECHNIQUES. J. G. Adler (Dalhousie Univ., Halifax, N. S.). Can. J. Phys., 43: 594-604(Apr. 1965).

Some of the properties of superconducting lead-bismuth alloy films were investigated using electron tunneling techniques. The superconducting energy gaps and transition temperatures as well as the effective tunneling density of electron states near the end point of the phonon spectrum were measured for various compositions of this alloy system. It was found that pure bismuth films as well as bismuth films containing small amounts of lead are not superconducting above 1°K. The results also indicated that for alloys with bismuth concentrations between about 35% and 75%, superconductivity is due partially to a proximity effect. (auth)

23544 INFLUENCE OF THE CURRENT INTENSITY ON THE NORMAL STATE-SUPERCONDUCTING STATE TRANSITION FOR TINS OF DIFFERENT PURITIES. Robert Reich and Louis Renucci (CNRS, Vitry-sur-Seine, France). Compt. Rend., 260: 1178-81(Jan. 25, 1965). (In French)

It is shown that the reference temperature of 3.75°C is suitable only for the study of the transition in the case of pure tin. The critical temperature T_c, defined in the classic manner, has significance only with respect to the resistivity detected. The intermediary state (coexistence of metal in the normal state and of metal in the superconducting state in the sample) is maintained at temperatures lower than those predicted by the London model. (tr-auth)

23545 STUDY OF THE CRITICAL TEMPERATURE OF NORMAL STATE-SUPERCONDUCTOR STATE TRANSITION OF TIN. Robert Reich and Louis Renucci (CNRS, Vitry-sur-Seine, France). Compt. Rend., 260: 1408-11(Feb. 1, 1965). (In French)

It is shown that for a given current intensity the critical temperature T_c tends toward a limit T_{cL} when the sensitivity of the means of detection of the electrical resistivity increases. The lines express the variation of T_c and T_{cL} as a function of the current intensity for different sensitivities converging in a point called the "real critical temperature" T_R. This temperature which corresponds to the transition in magnetic field and zero current varies with the purity and is elevated from 2.713°K for the metal Pass no. 1 to 3.720°K for fused-zone metal. (tr-auth)

23546 THE USE OF GRAPHITE THERMOMETERS IN HEAT CONDUCTIVITY EXPERIMENTS BELOW 1°K. A. Dupre, A. Van Itterbeek, L. Michiels, and L. Van Neste (Instituut voor Lage Temperaturen en Technische Fysica, Louvain, Belg.). Cryogenics, 4: 354-7(Dec. 1964).

The construction and features of graphite thermometers used to measure the absolute temperature and the temperature gradient of copper rods are described. The methods for measuring the resistances and procedure for calibrating the thermometers are discussed. A resistance-temperature relation was found for the graphite thermometer below 1°K, and a method for making corrections to the resistance measurement for the two thermometers is presented. (L.B.S.)

23547 HYDROGEN LIQUEFIERS WITH EFFICIENT HEAT EXCHANGERS. E. S. Borovik, I. F. Mikhailov, and N. A. Kosik (Inst. of Physics and Tech., Academy of Sciences, USSR). Cryogenics, 4: 358-60(Dec. 1964).

A description is given of the single-stage cooling VO-10 hydrogen liquefier and the two stage cooling V-50 liquefier. The construction of the liquefiers is shown, and the main test results are presented. (L.B.S.)

23548 VAPOUR PRESSURE RELATIONSHIPS UP TO THE CRITICAL POINT OF HYDROGEN, DEUTERIUM, AND TRITIUM, AND THEIR DIATOMIC COMBINATIONS. H. M. Mittelhauser and G. Thodos (Northwestern Univ., Evanston, Ill.). Cryogenics, 4: 368-73(Dec. 1964).

A comprehensive study was made of the vapor pressure behavior of hydrogen, deuterium, and tritium and their different diatomic combinations. Experimental data were plotted to establish the best vapor pressure values, from

which the complete vapor pressure function between the triple point and the critical point was established. Calculations were then made of the constants for those substances for which experimental data were lacking, and the results are tabulated. (L.B.S.)

23549 GROWTH OF TURBULENCE IN THE FLOW OF LIQUID HELIUM II. E. S. Raja Gopal and S. M. A. Tirmizi (Oxford Univ.). Cryogenics, 4: 378-86(Dec. 1964).

The studies of the supercritical flow in narrow capillaries show that turbulence does not develop homogeneously throughout the length of the tube but instead propagates from the two ends in the form of well developed fronts. The dependence of this phenomenon on the heat current, the ambient temperature at which the measurements are made, and the capillary diameter is studied. The results of measurements of the transient stages in heat conduction through liquid helium II with tubes of 774 and 499 μ are reported and discussed. (L.B.S.)

23550 LOW-TEMPERATURE WORK IN JAPAN. K. Oshima (Tokyo Univ.). Cryogenics, 5: 1-8(Feb. 1965).

The industrial low-temperature research activities in progress in Japan on superconductivity, semi-metals, magnetism, and semiconductors are reviewed. Other low-temperature activities include studies of thermometry, ionic crystals, mechanical properties of metals, helium liquefiers and refrigerators, and development of cryogenic equipment. The institutions engaged in low-temperature work are listed. (L.B.S.)

23551 DEGRADATION OF TYPE-II SUPERCONDUCTORS. R. Weyl and I. Dietrich (Siemens and Halske AG, Munich). Cryogenics, 5: 9-11(Feb. 1965).

The influence of the circulating currents on the critical transport current of cold-worked and annealed Nb(80 at. %)-Ti wires is described qualitatively using magnetization curves. Critical values measured with coils are compared with quenching curves of short wire samples. The superposition of the transport and circulating currents in the type-II superconductor is demonstrated using the example of the toroid of a type-I superconductor. (L.B.S.)

23552 EFFECT OF CHANNEL GEOMETRY ON THE GROWTH OF VORTICITY IN LIQUID HELIUM II. E. S. Raja Gopal and S. M. A. Tirmizi (Oxford Univ.). Cryogenics, 5: 21-6(Feb. 1965).

Experiments were performed with various geometrical configurations of insulated german silver capillaries with one end opening into a liquid helium II bath and the other end closed by means of a heater. The qualitative features of the initiation and growth of vorticity are obtained. The main results are: the turbulence phenomenon is an intrinsic and reproducible property of the flow characteristics of the liquid in a given tube; the nucleation of turbulence requires a velocity discontinuity, the superfluid-normal fluid flow being altered in a distance comparable to the lateral size of the channel; the turbulence, once it is created, propagates in well defined fronts with velocites that depend at a given temperature only upon the heat current density in that channel; the density of the vorticity and the velocity of the fronts have no correlation with the nature or location of the nucleation source. (L.B.S.)

23553 THE MEASUREMENT OF TRANSITION TEMPERATURE OF SUPERCONDUCTING FILMS ON NORMAL SUBSTRATES. E. J. Milligan (Plessey Co. Ltd. Caswell Research Labs., Towcester, Northants, Eng.). Cryogenics, 5: 49(Feb. 1965).

It is pointed out that the usual criterion for defining transition temperatures is invalid when applied to composite superconductors, which results in an error for the measured value of Tc. (L.B.S.)

23554 A DEVICE FOR MEASUREMENTS OF THE LOCAL CRITICAL CURRENTS OF A LONG SUPERCONDUCTING WIRE. M. G. Kremlev, B. N. Samoylov, and S. S. Skulatchenko. Cryogenics, 5: 73-5(Apr. 1965).

An automatic device is described that allows the measurement of the uniformity of critical currents along a 50 ft superconducting wire, when any point of the wire is submitted to a local field up to 40 kOe. Preliminary results of such measurements are reported. (auth)

23555 MAGNETIC PROPERTIES OF A CYLINDRICAL ENCLOSED SUPERCONDUCTOR. R. L. Gayley. Cryogenics, 5: 89-93(Apr. 1965).

The magnetic behavior of a coaxial cable arrangement of superconductors is calculated. By defining an effective demagnetizing coefficient, it is shown that the behavior is exactly analogous to that of the familiar ellipsoidal specimens. It is pointed out that the intermediate state of the inner conductor should consist of a small number of large normal and superconducting regions instead of the more common arrangement of fine laminae. This makes the system well suited to studies of intermediate states and surface energies. The weak field behavior of very small specimens is analysed to show that in this case the transition temperature of the inner conductor is reduced by an amount proportional to $(H_T/\lambda_0)^2$, where H_T is the trapped field and λ_0 is the penetration depth at absolute zero. This result shows that such a device could be useful as a weak field magnetometer and for measurements of penetration depths. (auth)

23556 A CRYOSTAT FOR MÖSSBAUER EXPERIMENTS IN THE TEMPERATURE RANGE 4-300°K. W. Wiedemann, W. A. Mundt, and D. Kullmann. Cryogenics, 5: 94-100(Apr. 1965).

The design and construction of a gas cryostat, especially built for Mössbauer experiments, and operating in the temperature range 4–300°K, is described. Heat balance equations are given. Data are supplied concerning liquid helium consumption and temperature control. The problem of heat exchange in the sample chamber is discussed. (auth)

23557 FIELD EMISSION AT 9000 Gc/s IN A SUPERCONDUCTING CAVITY. H. Zimmer (Philips Zentrallaboratorium GmbH, Hamburg). Electron. Letters, 1: 24(Mar. 1965).

The field emission of a microwave cavity with a lead superconductor and a tungsten field-emission cathode was detected by the dependence of Q on the input power. The effective beam resistance and the effective beam current were calculated from the results. (L.B.S.)

23558 A MINIATURE JOULE-THOMSON CASCADE LIQUEFIER CRYOSTAT FOR HELIUM. B. N. Srivastava, J. K. N. Sharma, S. Chatterjee, and S. K. Sen (Indian Assn. for Cultivation of Science, Calcutta). Indian J. Phys., 38: 535-44(Nov. 1964).

A miniature cascade helium liquefier cryostat is described and various constructional details are given. The liquefier is designed to enable experiments at liquid helium temperatures to be performed in an ordinary laboratory and uses only liquid oxygen for the initial cooling. The liquid hydrogen needed to cool the helium below its inversion temperature is provided by a hydrogen circuit liquefying hydrogen continuously within the same machine. Compressed cylinder hydrogen is used avoiding the necessity of compressor or gasometer for hydrogen. (auth)

23559 ROLE OF THE ION CORE IN THE MECHANISM OF SUPERCONDUCTIVITY. G. Gusman and R. Brout (Universite Libre, Brussels). J. Phys. Chem. Solids, 26: 223-32(Feb. 1965).

It is shown that if the primary contribution to the bulk modulus of a metal is due to interactions between the ion cores rather than the bulk modulus of the conduction electrons then the effective electron-electron interaction at low frequencies is repulsive. This is in contrast to the usual attractive interaction due to phonon mediated electron-electron interactions. The result is that superconductivity is suppressed for sufficiently strong core interactions. We find that, if at least two thirds of the bulk modulus is due to the core, superconductivity is suppressed. This condition is easily satisfied by the noble metals, so that our mechanism could very possibly explain the absence of superconductivity in these substances. (auth)

23560 CRYSTAL CHEMISTRY AND SUPERCONDUCTIVITY OF PRESSURE-INDUCED PHASES IN THE In–Te

SYSTEM. S. Geller, A. Jayaraman, and G. W. Hull, Jr. (Bell Telephone Labs., Murray Hill, N. J.). J. Phys. Chem. Solids, 26: 353-61(Feb. 1965).

In the In–Te system, a pressure-induced NaCl-type phase exists in the region $In_{0.80}Te$ to $In_{1.15}Te$. Superconductivity exists in the whole range, with the maximum transition temperature occurring for the stoichiometric InTe. A hypothesis previously given for the metallic behavior of this phase and the decrease of transition temperature on either side of the stoichiometric InTe is further elaborated. It is proposed that the transformation to the NaCl-type structure removes the structural constraint on electron transfer existing in the normal InTe. A method for calculating carrier concentration is given and it is shown that the superconducting transition temperature is a function of carrier concentration. At least two other pressure-induced In–Te phases exist. One is In_3Te_4 which becomes superconducting at 1.25 to 1.5°K. In_3Te_4 has the anti-Sn_4As_3 structure with seven atoms in a rhombohedral unit cell, all lying on the threefold axis. The positional parameters of the atoms and interatomic distances are given and the coordination shown to be related to that found in the NaCl-type structure. Pressure-temperature experiments on normal In_2Te_3 indicate that a pressure-induced phase with this (or approximately this) composition cannot be obtained metastably without the presence of the In_3Te_4 and an unidentified phase. The pressure-induced In_2Te_4 phase has the well-known Bi_2Te_3 structure and is closely related to the In_3Te_4 structure. Superconductivity tests and x-ray diffraction investigation lead to the conclusion that the In_3Te_4 phases occurring with the In_2Te_3 phase are sometimes not stoichiometric and in such cases usually contain excess tellurium. (auth)

23561 CRITICAL TEMPERATURE BREADTH OF SUPERCONDUCTING TIN–INDIUM SINGLE CRYSTAL ALLOYS. Takafumi Aomine, Hironobu Abe, and Yoshio Shibuya (Kyusyu Univ., Fukuoka, Japan). J. Phys. Soc. Japan, 20: 282(Feb. 1965).

The relation between the critical temperature breadth and the In concentration in dilute Sn-In single crystal alloys was investigated. Magnetization was measured as a function of applied magnetic field in annealed samples. The three critical fields are plotted against temperature for the 2.43 at. % In specimen. The three critical temperatures are given as functions of impurity In concentration; the critical temperature breadth seems to become narrower with lower In concentration. (M.J.T.)

23562 MAGNETIC PROPERTIES OF A TYPE-II SUPERCONDUCTOR: In–5% at. Pb ALLOY. Koshichi Noto, Yoshio Muto, and Tadao Fukuroi (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 20: 467(Mar. 1965).

The magnetization of In (5 at. %)-Pb was measured down to 0.38°K by a ballistic method. The temperature dependence of the thermodynamic and upper and lower critical fields is given. The Ginzburg-Landau parameter, evaluated in three different ways, is given as a function of temperature and compared with theoretical predictions. (M.J.T.)

23563 HYSTERESIS AND GRAIN SIZE EFFECTS IN THE SUPERCONDUCTING PHASE TRANSITION. J. C. Brice (Mullard Research Labs., Redhill, Surrey, Eng.). Nature, 205: 1096(Mar. 13, 1965).

A cell model, which gives a simple qualitative explanation for hysteresis and grain size effects in the superconducting phase transitions, is proposed. (C.E.S.)

23564 PRECESSION OF FLUX IN SUPERCONDUCTING INDIUM. Warren DeSorbo (General Electric Research Lab., Schenectady, N. Y.). Phil. Mag. (8), 11: 853-62(Apr. 1965).

A new effect concerning precession of motion of flux spots and of superconducting-normal interface was observed in indium with the magneto-optic technique. The direction of precession reverses when the field direction is reversed. An explanation proposed independently by Pippard and Faber is based on the Hall effect. Other macroscopic features pertaining to the dynamic effects and to the steady-state patterns in the intermediate state are similar to those seen in other type-I superconductors when the Ginzburg-Landau parameter is small (Al, Sn). (auth)

23565 SUPERCONDUCTING CRITICAL TEMPERATURES OF THE CARBIDES AND NITRIDES WITH THE NaCl STRUCTURE: SUPERCONDUCTIVITY OF MoC. L. E. Toth (Univ. of Minnesota, Minneapolis), E. Rudy, J. Johnston, and E. R. Parker. Phys. Chem. Solids, 26: 517-22(Mar. 1965).

The superconducting transition temperatures of the metallic carbides and nitrides with the NaCl structure are interpreted on the basis of the tight-binding model of BILZ. It is found that total valence electron concentrations from 9 to 10 are required for high critical temperatures in these compounds. The cubic modification (NaCl) of molybdenum carbide was found to be superconducting at 13.0°K in agreement with the Bilz band model. (auth)

23566 SUPERCONDUCTING STATE PARAMETERS IN DILUTE ALLOYS. Lewis T. Claiborne (Texas Instruments Inc., Dallas). Phys. Chem. Solids, 26: 653-7(Mar. 1965).

A semi-empirical formalism is presented for the calculation of transition temperature, thermodynamic critical field, and specific heat in dilute alloys of type-1 superconductors. The calculation is based on an extension of a 'local strain field' model previously introduced for the concentration dependence of the transition temperature. The size effect in transition metals is compared with the model for dilute alloys. (auth)

23567 SOME NEW SUPERCONDUCTING COMPOUNDS. D. C. Hamilton (Univ. of California, San Diego, La Jolla), Ch. J. Raub, B. T. Matthias, E. Corenzwit, and G. W. Hull, Jr. Phys. Chem. Solids, 26: 665-7(Mar. 1965).

Superconductivity was previously observed in pure Ir and in Pt-rich solid solutions, and it was previously suggested that pure Pt may be superconducting at sufficiently low temperatures. The superconductivity of some intermetallic compounds, eight of which contain appreciable amounts of gold, is reported. It is assumed that the superconducting behavior of the compounds gives information about the pure element. It is then inferred that superconductivity in the noble elements may extend from Ir through Pt even as far as Au. (auth)

23568 SUPERCONDUCTIVITY OF THE ALKALI TUNGSTEN BRONZES. A. R. Sweedler, Ch. J. Raub, and B. T. Matthias (Univ. of California, San Diego, La Jolla). Phys. Letters, 15: 108-9(Mar. 15, 1965).

Superconductivity measurements were made on powdered samples of $NaWO_3$, KWO_3, $RbWO_3$, $CsWO_3$, having either the tetragonal I or hexagonal symmetry. The measurements were made by monitoring the self-inductance of a coil containing the sample. It was found that 80 to 90% of the total volume of the sample exhibited superconductivity, and that superconductivity is a general property of alkali tungsten bronzes. (L.B.S.)

23569 SUPERCONDUCTIVITY OF ZIRCONIUM ISOTOPES. E. Bucher (Universite, Geneva). J. Muller, J. L. Olsen, and C. Palmy. Phys. Letters, 15: 303-4(Apr. 15, 1965).

The effect of the isotopic mass, M, on the superconducting transition temperature, T_c, of zirconium was investigated, and it was found that the value of the exponent α in the expression T_c is proportional to $M^{-\alpha}$ is given by $\alpha = 0 \pm 0.05$. (C.E.S.)

23570 JOSEPHSON AC AND STEP STRUCTURE IN THE SUPERCURRENT TUNNELING CHARACTERISTIC. D. D. Coon and M. D. Fiske (General Electric Research Lab., Schenectady, N. Y.). Phys. Rev., 138: A744-6(May 3, 1965).

Superconductive tunneling junctions exhibiting the Josephson effect will carry appreciable currents (~50 mamp) with no voltage drop in the absence of any magnetfc field. In applied fields of a few gauss the current-voltage characteristic becomes steplike, with appreciable currents now

being carried in constant-voltage steps at regularly spaced voltages. It is shown that these steps are associated with resonant electromagnetic modes of the junction, which acts as an open-ended cavity. The lowest frequency mode in junctions made so far occurs at ~5 kMc, and is set by the junction dimensions. The highest mode occurs near the half-energy gap of the superconductor used for the junctions — for tin, about 250 kMc. (auth)

23571 TUNNELING INTO DIRTY SUPERCONDUCTORS NEAR THEIR UPPER CRITICAL FIELDS. E. Guyon, A. Martinet, J. Matricon, and P. Pincus (Faculte des Sciences, Orsay, France). Phys. Rev., 138: A746-52(May 3, 1965).

Experiments on tunneling into SnIn and PbBi alloys near their upper critical fields are described. In this regime, a theory by de Gennes predicts gapless superconductivity with a density of excited states whose energy scale is field-independent. This density of states was investigated in detail, both in the superconducting sheath regime near H_{c3} (field parallel to the surface) and in the vortex regime near H_{c2} (field normal to the surface). Excellent agreement was found between theory and experiment for the shape of the tunneling characteristic and reasonable agreement for its normalization. (auth)

23572 GINZBURG-LANDAU EQUATIONS AND THE JOSEPHSON EFFECT. Donald A. Jacobson (Philco Corp., Newport Beach, Calif.). Phys. Rev., 138: A1066-70 (May 17, 1965).

A self-consistent model is developed for the Josephson effect based on the Ginzburg-Landau phenomenological equations. In this approach, the gap behaves like a weak superconductor, with the maximum Josephson current as its critical current. An expression is derived for the maximum Josephson current, for the case of two identical superconductors and no external magnetic field, in terms of an effective barrier height and width, the weak-field penetration depth, and the bulk critical field. The expression is first derived for a one-dimensional configuration, and then shown to remain valid for certain thin-film junctions. Using 1 ev for the barrier height and 10 Å for the barrier width, the maximum Josephson current turns out to be 0.38 A/cm^2 for pure-tin junctions. For the same sample a penetration depth of 2.06 mm is obtained at the center of the gap for the maximum current. (auth)

23573 SUPERCONDUCTING AND NORMAL STATE PROPERTIES OF DILUTE INDIUM–TIN ALLOYS: BULK AND THIN FILM. A. M. Toxen, M. J. Burns, and D. J. Quinn (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., 138: A1145-54(May 17, 1965).

Measurements are reported of normal-state and superconducting-state properties of bulk and thin-film indium–tin alloys. For the bulk samples, whose compositions were in the range 0–5.8 at. % tin, the residual resistivities, critical magnetic fields, and critical temperatures were measured. It is shown that both similarity conditions are well obeyed for the critical fields of samples containing 0–1.8 at. % Sn, for which detailed data were taken. High-purity films were produced containing up to 5 at. % tin. From resistance measurements, the critical temperatures, critical fields, thicknesses, and residual resistivities of the films were obtained. The formula for boundary scattering due to Fuchs was recast into a more convenient form from which one may calculate the intrinsic mean free path and intrinsic resistivity directly from the measured resistivity and thickness. From the resistivity measurements, one may infer a value for the product of intrinsic resistivity and mean free path, ρl, of 1.6×10^{-11} Ω cm^2. The critical-temperature measurements indicate that bulk and film specimens having the same composition do not have the same critical temperature. On the basis of a model which attributes the shift in critical temperature to stress effects, formulas are derived from which one may calculate the stress in a film as well as the equivalent (i.e., stress-shifted) bulk critical field for any film. However, the stress-shifted bulk critical-field curves obtained in this way for the indium alloy films are nearly the same as one would have obtained under the assumption of similarity. Analysis of the critical-temperature results indicates that while stresses in the most dilute films are probably relieved by ordinary dislocation flow, some other mechanism, perhaps twinning, dominates in the more concentrated alloys. The largest uniaxial stress calculated for the films studied was 2.6×10^9 dyne/cm^2, which was obtained for a film of indium containing 2.6 at. % tin. (auth)

23574 AN ADDITIONAL EQUATION IN THE PHENOMENOLOGY OF SUPERCONDUCTIVITY: RESISTIVE EFFECTS. P. W. Anderson (Bell Telephone Labs., Murray Hill, N. J.), N. R. Werthamer, and J. M. Luttinger. Phys. Rev., 138: A1157-9(May 17, 1965).

A phenomenological derivation and a discussion of the "extra Ginzburg-Landau equation" which connects the charge, electrical potential, and time dependence of the order parameter in a superconductor is presented. (auth)

23575 PHONON "IMPURITY BAND" IN DILUTE SOLUTIONS OF In IN Pb OBSERVED BY SUPERCONDUCTING TUNNELING. J. M. Rowell, W. L. McMillan, and P. W. Anderson (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Rev. Letters, 14: 633-4(Apr. 19, 1965).

Experiments are described in which the sensitive technique of tunneling between superconductors demonstrates the presence of an impurity band of phonons in a dilute solution of In in Pb. The second derivative of tunnel current versus voltage is shown for an Al-I-$Pb_{0.97}$ $In_{0.03}$ junction. The shape of the impurity band is determined using programs which were previously described for the inversion process of calculating the phonon spectrum for the tunneling data. (L.B.S.)

23576 PARAMAGNETIC HELICAL CURRENT FLOW IN TYPE-II SUPERCONDUCTORS. M. A. R. LeBlanc, B. C. Belanger, and R. M. Fielding (Univ. of Southern California, Los Angeles). Phys. Rev. Letters, 14: 704-7 (Apr. 26, 1965).

Observations of an increase in the longitudinal flux threading type-II superconducting wires in an applied longitudinal field when a transport current is introduced in the specimen are reported. This phenomenon, called the longitudinal paramagnetic effect, indicates that the current carriers in type-II superconductors follow paramagnetic helical trajectories. The measurements were performed on Nb–Zr and Nb–Ta wires. (C.E.S.)

23577 APPLICATION OF A SUPERFLUID GYROSCOPE TO THE STUDY OF CRITICAL VELOCITIES IN LIQUID HELIUM NEAR THE λ TRANSITION. John D. Reppy (Yale Univ., New Haven). Phys. Rev. Letters, 14: 733-5(May 3, 1965).

An experiment designed to obtain information on the stability of superfluid flow in the vicinity of the λ transition is described. A method that allows repeated nondestructive measurements of the persistent current angular momentum was used. The superfluid current is formed in an annular container. The walls of the container are thin magnesium, and the interior is filled with a fibrous foam to increase the critical velocity. This system constitutes a superfluid gyroscope where the rotating element is frictionless superfluid. (C.E.S.)

23578 UNSTABLE DOMAIN STRUCTURE IN THE INTERMEDIATE STATE OF SUPERCONDUCTORS. B. Lalevic (Franklin Inst. Philadelphia). Phys. Status Solidi, 9: 63-72(1965).

Measurements of resistance fluctuations, metastable resistance levels, and related parameters were extended to the case of the intermediate state of a specimen carrying a variable current in a constant external magnetic field. The origin of peculiar peaks in the plots of relative changes of resistance $\Delta R/R$ is now clarified and related to metastable resistance levels. The influence of specimen current on the shape of the resistance vs external magnetic field plot is explained on the basis of the present measurements. From a comparison of these and previously obtained data with the theory of domain boundary propagation, the conditions for the occurrence of domain boundary instabilities are derived; and a mechanism responsible for the appearance of resistance fluctuations is discussed. (auth)

23579 THEORY OF SUPERCONDUCTIVITY OF ELECTRON SYSTEM CONTAINING SINGLET AND TRIPLET PAIRS. S. V. Vonsovskii and M. S. Svirskii (Inst. of Metal Physics, Academy of Sciences, USSR and Tchelyabinsk Pedagogical State Inst., USSR). Phys. Status Solidi, 9: 267-80(1965).

The general case of a superconductor with singlet and triplet pairs is investigated. The method uses the B-operators for creation and annihilation of singlet and triplet pairs, and A-operators for interchange of multiplicity of these pairs. The theory uses the properties resulting from the symmetry type of the electron-pair wave function which do not involve the conventional assumptions regarding the dependence of the matrix element $V_{\kappa\kappa}$ on the vectors κ and κ'. A more general form of electron-pair Hamiltonian is proposed which includes both the previously discussed exchange terms and those due to the alternation of electron-pair multiplicity. The variational problem for the coexistence of singlet and triplet pairs is solved. The trial wave functions are established both from the properties of the B-operator and the generalized unitary Yosida operator for singlet and triplet pairs. The physical significance of the limitations imposed on the solutions of the superconductive problem with triplet pairs is clarified. The distribution functions are established for the different types of pairs and it is shown that the solutions for an isotropic gap may correspond to an anisotropic distribution of these pairs. The properties of a superconductor at non-zero temperature are investigated using both the method of double-time Green's functions and the method of variation of the thermodynamic potential with the interaction parameter. Some modifications are considered which permit an analysis of the problem by quantum-field techniques. (auth)

23580 DEVICE FOR STUDYING HIGH-FREQUENCY ULTRASONICS IN SUPERCONDUCTORS. A. G. Shepelev and G. D. Filimonov (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Pribory i Tekhn. Eksperim., No. 1, 194-8(Jan.-Feb. 1965). (In Russian)

A device for the investigation of pulses by the method of temperature dependence of the absorption of ultrasonics in superconductors at temperatures from 4 to 1°K was described. The low-temperature part of the device, pulse generator (frequency up to 300 Mc), modulator and receiver in which the conversion switch of the television channel PTK-12 was used were the components discussed. The converter switch made it possible to expand the range of frequencies used. (J.S.R.)

23581 CRYOSTAT FOR TENSION TESTING IN THE TEMPERATURE RANGE 4 TO 300°K. G. U. Behrsing and L. R. Lucas (Univ. of California, Berkeley). Rev. Sci. Instr., 36: 617-20(May 1965). (UCRL-11571; UCRL-11571 (Rev.))

A cryostat with a load capacity of 10,000 lb was designed for use with standard tensile-testing equipment in the temperature range from 4 to 300°K. Specimens up to 12.7 cm long can be mounted easily on the grip rods through an opening in the front of the test chamber. The cryostat is used in conjunction with a 10,000-lb Instron tension-testing machine containing a stress-strain recorder and strain pacer. (auth)

23582 ON THE TUNNEL EFFECT FOR SUPERCONDUCTORS IN THE MICROWAVE FIELD. Eberhard Riedel (Universitat, Cologne). Z. Naturforsch., 19a: 1634-5 (Dec. 15, 1964). (In German)

The Cohen-Falicov-Phillips model was used to calculate the current-voltage characteristics of superconductor contacts with consideration of a microwave field. Modified Josephson terms and a step structure in the direct current characteristics were obtained. The effects were observed by Shapiro. (tr-auth)

23583 TEMPERATURE DEPENDENCE OF THE UPPER CRITICAL FIELD OF SUPERCONDUCTING ALLOYS. L. Tewordt (Universitat, Hamburg). Z. Physik, 184: 319-24(1965).

The upper critical field, H_{c2}, is calculated in the temperature range close to T_c for arbitrary values of the mean free path. The method is to treat the fourth-order term in the linearized differential equation for the gap parameter as a perturbation to the harmonic oscillator equation. The Nambu-Tuan term, which determines the structure of the clean-limit and dirty-limit parts of the fourth-order term, is calculated by means of the ladder diagram technique for impurity interaction lines. The result is that the magnitude of the slope of the curve $H_{c2}/\sqrt{2}H_c\kappa$ versus $t = T/T_c$ at $t = 1$ decreases monotonically from 0.41 to 0.12 as the ratio of the BCS coherence length ξ_0 to the mean free path increases from 0 to ∞. For mean free path $\simeq\xi_0$ this slope is about 0.26. (auth)

23584 ON SUPERCONDUCTING THERMAL SWITCHES. V. P. Peshkov and A. V. Parshin (Inst. of Problems in Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 48: 393-403(Feb. 1965). (In Russian)

The thermal conductivity of a number of thermal switches at temperatures of 0.3–2°K is measured in various magnetic fields. The efficacy of superconducting thermal keys and the effect of the purity and dimensions of the samples on the thermal conductivity are assessed theoretically. (auth)

23585 ON SOLUTION OF THE SUPERCONDUCTIVITY EQUATIONS FOR A SYSTEM OF SUPERCONDUCTING AND NORMAL METALS. R. O. Zaitsev. Zh. Eksperim. i Teor. Fiz., 48: 644-51(Feb. 1965). (In Russian)

The superconductivity equations are solved for a system of superconducting and normal metals. The samples are assumed to be semi-finite and the temperature to be near the superconducting transition temperature. Asymptotic solutions are obtained for distances from the boundary which greatly exceed the dimensions of the Cooper pair. Effective boundary conditions for the Ginzburg-Landau equations can be derived from the asymptotic solutions. (auth)

23586 DESTRUCTION OF SUPERFLUIDITY OF He^3 IN A MAGNETIC FIELD. I. A. Privorotskii. Zh. Eksperim. i Teor. Fiz., 48: 723-30(Feb. 1965). (In Russian)

It is shown that in a strong magnetic field (of the order of $3-5\times10^4$ Oe) superfluidity of liquid ^{3}He should be destroyed since formation of Cooper pairs in the singlet state becomes unprofitable. Destruction of superconductivity in the Gorkov-Galitsky model should occur as a result of a phase transition of the first kind. Supercooling and superheating should be possible in this case. Along with the thermodynamic critical field H_k two other critical field strengths H_{k1} and H_{k2} should exist at a given temperature ($H_{k1} < H_k < H_{k2}$) and define the metastability region. The surface tension in the Anderson-Morel model is apparently negative at the boundary between the superfluid and normal phases. Therefore destruction of superfluidity by a magnetic field should occur in about the same manner as in superconductors of the second kind. In this case $H_{k2} < H_k < H_{k1}$ and for $H > H_{k2}$ formation of normal phase layers becomes advantageous. Liquid ^{3}He completely changes into the normal state in a field $H > H_{k1}$. (auth)

23587 THEORY OF SUPERCONDUCTIVITY. John M. Blatt. Pure and Applied Physics. A Series of Monographs and Textbooks. Volume 17. New York, Academic Press, 1964. 498p.

Fundamental properties of superconductors are described. The model of a charged Bose-Einstein gas is considered. The concept of correlated electron pairs in metals and the "quasi-chemical equilibrium theory" built on that concept are discussed. It is shown that, in spite of the Fermi-Dirac statistics of unpaired electrons, and in spite of the high density of the electron gas in metals, a Bose-Einstein-like condensation of electron pairs is possible, and that this is the basic mechanism producing the superconducting state. A self-consistent treatment of the pairing wave function for the ground state is given, and the qualitative consequences of the resulting solution given. The method of creation and destruction of operators, the relation of the ground state wave functions of the BCS theory and the Bogoliubov theory, the thermodynamic

theory of superconductivity, and the theory of transport properties associated with "Bogolon" excitations are discussed. The Meissner-Ochsenfeld magnetic field expulsion and the persistent electric currents in superconducting rings are considered. (M.C.G.)

23588 LOW TEMPERATURE TECHNIQUES. The Use of Liquid Helium in the Laboratory. A. C. Rose-Innes. Princeton, New Jersey, D. Van Nostrand Company, Inc., 1964. 172p.

Design and construction of apparatus for low-temperature experiments using liquid He are discussed for experimentalists unfamiliar with low-temperature techniques. Storage and handling of liquid and gaseous He, design of cryostats, experimental techniques, use of ^{3}He to produce temperatures below 1°K, thermometry, and temperature control above and below 1°K are considered. A collection of data useful in the design of low-temperature apparatus and experiments is included. (M.J.T.)

23589 THEORY OF SUPERCONDUCTIVITY. J. R. Schrieffer. Frontiers in Physics. A Lecture Note and Reprint Series. New York, W. A. Benjamin, Inc., 1964. 294p.

Fundamentals of the microscopic theory of superconductivity are presented. A brief review of simple experimental facts and phenomenological theories of superconductivity is given. The original BCS pairing theory is described, and applications of the theory are worked out, including applications to acoustic attenuation rate, nuclear-spin relaxation rate, electromagnetic absorption, coherence factors, and electron tunneling. The many-body aspects of the coupled electron-ion system are developed; the basis for treating strong quasiparticle damping effects is considered. Elementary excitations in normal metals are discussed. A field-theoretic treatment of the superconducting state is given, treating the noninstantaneous nature of the interaction causing superconductivity and the breakdown of the quasiparticle approximation. Electromagnetic properties of superconductors and collective excitations of the system are considered. (M. J. T.)

23590 SOME NEW INVESTIGATIONS IN THE REGION OF LOW TEMPERATURES. H. B. G. Casimir. p.26-35 of "Physikertagung Hamburg." Mosbach/Baden, Ger., Physik Verlag, 1964. (In German)

The principal theoretical studies made in the region of low temperatures are discussed. The statistical principles of the Nernst heat theorem, low temperature properties of gases and liquids, solids of non-magnetic crystals and those with magnetic properties are considered. The present state of the theory of superconductors is described in some detail. (J.S.R.)

23591 A SEARCH FOR VORTEX LINES IN ROTATING SUPERFLUID HELIUM BY POSITRON ANNIHILATION. L. O. Roellig, T. Kelly, H. H. Madden, and J. McNutt (Wayne State Univ., Detroit). 12p. (CONF-651-74)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

A search was made for the possible existence of vortex lines in rotating superfluid He by using positrons and positronium atoms to detect the vortex core. Annihilation rates of positrons and singlet- and triplet-state positronium atoms were measured, using a ^{22}Na positron source in a rotating bucket full of liquid He. Results are given showing that there is not a large change in the lifetime of free positions and triplet positronium as function of rotational speed and temperature; explanations for the data, assuming the existence of vortex lines, are presented. (M.J.T.)

23592 PERSISTENT CURRENTS AND FLUX QUANTIZATION IN SUPERCONDUCTING RINGS INTERRUPTED BY JOSEPHSON JUNCTIONS. A. M. Goldman (Stanford Univ., Calif.). 7p. (CONF-651-86)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.–Sept. 1964.

The possibility that persistent currents will flow around closed rings interrupted by thin barriers, which exhibit Josephson tunneling, was studied in an experiment also designed for flux quantization studies in these rings. The sample consists of two rings of the same cross section and thickness constructed by evaporating a SiO strip over a lead plane. One is interrupted by two insulating junctions and the other is unbroken. The size of the flux quantum in the interrupted loop is compared with the known quantum in the unbroken loop. The I–V characteristics for parallel connection of the junctions were measured. (R.E.U.)

23593 ENHANCED TRANSFER RATES AND THICK HELIUM II FILMS. C. C. Matheson and J. Tilley (Univ. of St. Andrews, Fife, Scotland). 7p. (CONF-651-57)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The variable rate of superfluid flow of liquid helium II through saturated films was studied under various conditions by observing the rate of rise and fall of the helium meniscus in a cylindrical glass beaker as it is filled and emptied by film flow. In a test of the vorticity theory suggested by Allen, no alteration of the transfer rate was observed, and it was concluded that enhanced rates however produced are not associated with turbulence or vorticity in any way. It is also concluded that for film paths of equal height, variation in film thickness will result in a corresponding variation in transfer rate. It is found that the thick film is unstable to waves on its surface. (L.B.S.)

23594 SUPERCONDUCTING SOLENOID. R. W. Boom and L. D. Roberts (to U. S. Atomic Energy Commission). U. S. Patent 3,176,195. Mar. 30, 1965.

A superconducting solenoid is described, which uses a normally shorted copper secondary winding in intimate coupling with the turns of the superconductor primary winding. The shorted secondary winding is useful for dissipation of the released energy when the superconducting primary goes normal. Also, the use of a shorted secondary winding permits the primary winding to operate at a higher current (30 amp) than is possible without the secondary winding. Also, an auxiliary high resistance may be switched into the primary circuit at the transition to normal for further dissipation of released energy. The primary may be a 25% Zr–Nb alloy wire and the solenoid immersed in liquid helium at 4.2°K, for example. The solenoid can provide a magnetic field up to 20,000 gauss. (AEC)

Neutron Physics

See also REACTOR TECHNOLOGY — Criticality Studies.

Refer also to abstracts 22497 and 22797.

23595 (GA-5305) GRAPHITE INTERFACE STUDIES. Technical Summary Report, May 16, 1963–May 15, 1964. Part I. R. Bardes, J. Neill, and J. A. Young (General Atomic, San Diego, Calif.). May 15, 1964. Contract AT(04-3)-167. Dep.(mn); $3.00(cy), 3(mn) CFSTI.

A series of clean one-dimensional experiments of increasing complexity were performed on the graphite thermalization model to determine whether the SUMMIT type crystalline kernels used in a multigroup S_n transport formulation are capable of sufficient accuracy to predict thermal neutron spectra near absorption and temperature discontinuities. The facilities and experimental techniques used are described. The results of experiments indicated that the calculated spectra are too hard on the poisoned side of the interface. This is believed to be due to the heterogeneous nature of the assembly. Because of the target location and the increase in the absorption cross section as the interface is crossed, there is a net current flow from left to right across the interface in all energy groups. This current constitutes an appreciable fraction of the total source of thermal neutrons particularly for energies below 0.1 ev. In the calculations, the heterogeneous structure of graphite and poison is homogenized when generating macroscopic cross sections. Therefore a neutron, on crossing the interface immediately sees an appreciable absorption cross section. Experimentally how-

ever, many of the neutrons that cross the interface must scatter several times before they pass through the poison sheets. Since the scattering mean free path is of the order of one inch in graphite this implies that it might take several inches before equilibrium is reached and homogenized cross sections are valid. Plans for future experimental and analytical work are given. (P.C.H.)

23596 (RPI-328-20(p.1-8)) MULTIPLYING MEDIUM NEUTRON SPECTRUM MEASUREMENTS. R. J. Cerbone, R. E. Slovacek, R. R. Fullwood, and E. R. Gaerttner (Rensselaer Polytechnic Inst., Troy, N. Y.).

Reduction and analysis of data obtained in measurements on a cube of homogeneous ^{235}U fuel–zirconium oxide–paraffin mixtures are reported. The data were collected at the center and at the surface using the Poole technique to obtain the steady-state spectrum, and the pulsed linac-phased chopper technique was used and to measure the asymptotic spectrum. (J.R.D.)

23597 (RPI-328-20(p.9-15)) SPATIALLY DEPENDENT ASYMPTOTIC NEUTRON SPECTRUM MEASUREMENTS IN PURE MODERATORS. R. Fullwood, J. Menzel, G. Toth, and E. Gaerttner (Rensselaer Polytechnic Inst., Troy, N.Y.).

An automatic hole changer to improve normalization of spatially dependent measurements was used for neutron flux measurements on polyethylene slabs $7.55 \times 45.3 \times 45.3$ cm of density 0.921 g/cm^3. The assembly has 8 re-entrant holes for sampling the spectrum at various depths. The hole being used in the spectrum measurement is rotated to be on the neutron beam axis of the neutron spectrometer. Results of tests made to determine the spacing of holes that would not cause any observable interaction are tabulated. Data are also included on normalization by the use of overlapping spectra and spatial beam flux profiles. (J.R.D.)

23598 (RPI-328-20(p.16-23)) ANALYSIS OF THE EFFECTS OF COHERENT SCATTERING ON THE THERMALIZATION OF NEUTRONS IN BERYLLIUM. R. R. Fullwood, E. R. Gaerttner, and R. E. Slovacek (Rensselaer Polytechnic Inst., Troy, N. Y.).

Calculational procedures were applied to the largest medium having a buckling of 0.0131/cm^2. The results of these calculations are presented graphically. The buckling values were revised to obtain corrections for the buckling-dependent extrapolation length. Spectral data related to neutron thermalization in Be are included. (J.R.D.)

23599 (RPI-328-20(p.24-34)) INELASTIC SCATTERING—CHOPPER METHOD. G. J. Kirouac, W. E. Moore, K. W. Seemann, and M. L. Yeater (Rensselaer Polytechnic Inst., Troy, N. Y.).

Scattering data for nine incident energies and three scattering angles for polyethylene and water were reduced to cross sections. The doubly differential cross sections were integrated over final energy to obtain differential cross sections at each laboratory scattering angle. Values for these cross sections are included along with cross sections for water at four different incident energies. (J.R.D.)

23600 (RPI-328-20(p.35-9)) THE INELASTIC SCATTERING OF LOW-ENERGY NEUTRONS BY ZIRCONIUM HYDRIDE-1.37, THORIUM HYDRIDE AND NIOBIUM HYDRIDE. S. S. Pan, M. L. Yeater, F. Bischoff, and W. A. Bryant (Rensselaer Polytechnic Inst., Troy, N. Y.).

The spectra were measured at room temperature. Spectral data on the hydrides are presented graphically. (J.R.D.)

23601 MEASUREMENT OF DECAY CONSTANTS OF FAST NEUTRON FLUX IN MODERATOR MEDIA BY A TIME-OF-FLIGHT METHOD. G. Deconninck (Universite, Louvain, Belg.) and P. d'Oultremont. Ann. Soc. Sci. Bruxelles, Ser. I, 78: 193-9(Dec. 23, 1964). (In French)

The behavior of fast neutrons in nonmultiplying media was investigated using C, Cu, and Fe moderators. The time constants for the transmitted and reflected flux were calculated. The sharp asymmetry of the flux, plus the studies of others, showed the impossibility of using the scattering model to interpret correctly the evolution of populations of fast neutrons in moderating media. (J.S.R.)

23602 PROMPT-NEUTRON LIFETIME MEASUREMENTS WITH AN IMPROVISED TIME ANALYSER IN THE 'REACTOR PORTUGUES DE INVESTIGACAO (RPI)'. G. S. Brunson (International Atomic Energy Agency, Vienna) and J. M. C. Oliveira. At. Energy Rev., 2: No. 4, 95-103(1964).

The Rossi-α method makes use of the correlation of neutron detections to obtain the average period of prompt-neutron chains in a neutron multiplying system near critical. Pulses from a neutron detector of high sensitivity after amplification in conventional electronics are carried to a time analyzer, which, starting with some neutron pulse, examines subsequent increments of time for delayed coincidences. After many cycles of analysis, a distribution of delayed coincidences is obtained, which, when corrected for random events, yields an exponential slope corresponding to $\Delta K_D/\tau_\theta$, where ΔK_D is the reactivity of the system relative to prompt critical and τ_θ is the prompt neutron lifetime of the system. Normally the time analyzers used in this measurement are intricate and expensive, but it was found that the measurement could be made with minimal equipment: one conventional neutron detecting channel, an oscilloscope camera, and a motor-driven potentiometer. The sweep of the oscilloscope was triggered by neutron pulses; any pulses arriving during the sweep caused a momentary spot of light to appear at some x-coordinate representing the delay from the initiating pulse. These spots were recorded photographically and counted by hand. Analysis of data taken with a high-sensitivity fission counter yielded a prompt neutron lifetime of 48 ± 4 μsec as compared with a calculated lifetime of 52.8 μsec. Some criteria for feasibility are offered. In general a good experiment requires: a total spontaneous neutron source less than one fifth of a neutron/τ_θ, and a counter sensitivity greater than $0.01\sqrt{\tau_\theta}$ counts/fission (for reactors fueled with ^{235}U). For systems fueled with plutonium or uranium-233, the counter sensitivity should be greater than $0.002\sqrt{\tau_\theta}$ counts/fission. If a system has a low source level, the sensitivity requirements are substantially reduced. The best overall signal-to-noise ratio is obtained $1 below delayed critical; however, when the spontaneous source is small, it is desirable to make the measurement nearer delayed critical so that the data can be better extrapolated to delayed critical. (auth)

23603 LANDAU APPROXIMATION FOR THE CRITICAL INELASTIC MAGNETIC DIFFUSION OF NEUTRONS BY A FERROMAGNETIC. THE APPROXIMATION OF DIFFUSION OF SPIN. Joseph Seiden (Universite de Paris, Orsay, France). Compt. Rend., 260: 833-6(Jan. 18, 1965). (In French)

For low pulse transfers and if T is not too near T_c, the validity of the approximation of spin diffusion of Van Hove is shown. For $T = T_c$, an expression of the inelastic scattering cross section of neutrons is given. (tr-auth)

23604 A STUDY OF SPATIAL TRANSIENTS IN NEUTRON THERMALIZATION. M. M. R. Williams (Univ. of Birmingham, Eng.). J. Nucl. Energy, Pt. A & B, 19: 247-63(Apr. 1965).

The magnitudes of the spatial transients which are excited in the thermal neutron flux at a free boundary are discussed. As an example, the Milne problem in the two-group approximation is solved. The various contributions to the total flux and surface angular distribution due to the asymptotic, rethermalization, and continuum terms are compared and the limitations of diffusion theory for this type of problem are pointed out. The solution of the transport equation is based upon a novel iteration scheme which shows promise of rapid convergence. (auth)

23605 TIME-DEPENDENT NEUTRON SPECTRA IN D_2O. R. C. Kryter, R. R. Fullwood, and E. R. Gaerttner (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Nucl. Energy, Pt. A & B, 19: 265-7(Apr. 1965). (TID-21741)

The time-dependent neutron spectra were measured using a 50 cm cube of D_2O maintained at 110°F as the neutron source. The experimental technique utilizes a phased neutron chopper in conjunction with a pulsed linear accelerator. Spectral shifts from the asymptotic diffusion-cooled Maxwellian were observed at early times succeeding the fast pulse of high-energy neutrons. The differential spectrum was measured by the time-of-flight method, using a BF_3 end-window counter. The spectra are shown for different times after the initiating neutron burst. (L.B.S.)

23606 CONTRIBUTION OF HEAVIER NUCLEUS ON NEUTRON SLOWING DOWN IN HYDROGENOUS MIXTURE. [PART] I. Ryokichi Tanaka, Hiroji Mochizuki, Tuneaki Hamaguchi, and Kotaro Nagato (Kawasaki Dock Yard Co., Ltd., Kobe, Japan). J. Nucl. Sci. Technol. (Tokyo), 2: 83-90(Mar. 1965).

The problem of neutron slowing down in hydrogenous mixtures was studied from an analytical approach. The coupled slowing-down equations derived from P_1-diffusion, using the Goertzel-Greuling (G-G) or Fermi approximations were solved consistently; and detailed expressions for special cases are discussed. It is shown that, in a system comprising two kinds of nuclei, the neutron energy spectrum has a transient term near a source, representing an interference effect between the neutron moderation by the two different kinds of nuclei. The consequence of the G-G approximation is limited mainly to the transient region so long as absorption and leakage are negligible. When the mass of the non-hydrogenous nucleus becomes infinitely large, the general expression for the neutron energy spectrum derived from the G-G approximation coincides with the result from the simple Selengut-Goertzel method. (auth)

23607 DISTORTION OF NEUTRON COLLISION DENSITY DUE TO RESONANCE SCATTERING AND ABSORPTION. Hideo Kuroi and Hiroshi Mitani (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 2: 91-8(Mar. 1965).

An analytical method for obtaining the collision density and the resonance integral in a homogeneous mixture of moderator and absorber is presented. The method incorporates orthonormal expansion without any approximation such as narrow or wide resonance. A new orthonormal set of functions of which the weight function is of the shifted Breit-Wigner type is introduced for this purpose. Sample calculations are carried out for a mixture of ^{59}Co and heavy water, which is a typical case far removed from the two approximations mentioned. Comparison of the results with numerically obtained exact solutions shows that the first four terms of the expanded series are sufficient to express the collision densities in this case. (auth)

23608 THE EFFECT OF CYLINDRICAL HOLES IN A MODERATOR ON THE PASSAGE OF VIRGIN NEUTRONS FROM A POINT SOURCE. Hirokazu Murase (Kawasaki Dock Yark Co., Ltd., Kobe, Japan), Tamotsu Sekiya, and Tokuo Suita. J. Nucl. Sci. Technol. (Tokyo), 2: 99-103 (Mar. 1965).

The mean free path and the mean square free path of 14-Mev neutrons, generated isotropically from a d-t point source located at the center of the moderator region of a square lattice composed of parallel circular cylindrical holes in water, are calculated for various void ratios. Inequalities between the axial and transversal components of the mean free path and the mean square free path are found, which contradict the results of Behrens for homogeneous neutron sources. It is concluded that the effects on the free path lengths of the position of the point source located in an anisotropic and heterogeneous medium can not be neglected. (auth)

23609 ABSOLUTE CALIBRATION OF NEUTRON SOURCES. Y. Gurfinkel and S. Amiel (Soreq Nuclear Research Center, Yavne, Israel). Nucleonics, 23: No.3, 76-80(Mar. 1965).

The determination of the emission rate from a source calibrated by the $MnSO_4$-bath method is discussed, and experiments are summarized in which the accuracy of the method was investigated together with the parameters affecting the accuracy of the method. (D.C.W.)

23610 ON THE P_1 APPROXIMATION FOR THE TRANSPORT EQUATION DEPENDENT ON TIME AND ITS CONSEQUENCES. Ahmed Yueksel Oezemre (Atomic Energy Commission, Istanbul). Nukleonik, 7: 39-44(Jan. 1965). (In French)

It is shown that, in the non-stationary case, the expression for the neutron current vector $\vec{J}(\vec{r},t)$ and the diffusion equation obtained analytically in the framework of the P_1 approximation taking into account an anisotropy of the first order in the diffusion, do not include as particular cases $\vec{J}(\vec{r},t)$ and the diffusion equation corresponding to the elementary case of isotopic scattering. Always in the framework of the P_1 approximation, the expression for $\vec{J}(\vec{r},t)$ by which a new diffusion equation can be determined is obtained by means of a geometric method analogous to that used to determine the expression of the neutron current in the elementary diffusion theory. The expression of neutron current thus obtained and the new diffusion equation have the advantage of restoring for $\bar{\mu}_0 = 0$ the expressions corresponding to the case of elementary diffusion. The solution and some properties of this diffusion equation are then discussed, and the expression of the effective multiplication factor is derived in connection with the probability of neutron leakage at the exterior of the multiplying medium. (tr-auth)

23611 DIFFRACTION OF NEUTRONS BY MAGNETIC SUPERLATTICES. V. A. Levdik, V. N. Bykov, and V. S. Golovkin. Soviet Phys.-Cryst. (English Transl.), 9: 535-8 (Mar.-Apr. 1965). Translated from Kristallografiya, 9: 629-33(Sept.-Oct. 1964).

Elastic scattering of slow neutrons is discussed in terms of the general theory of x-ray diffraction. An expression was derived for the scattering power as a convolution of three functions; this provided a basis for analyzing the sizes of magnetic domains and structural imperfections. It was assumed that the latter are substantial, because of the dynamic features of the magnetic lattice. This feature was correlated with the concept of a "temperature coefficient of change in the superlattice parameter of the magnetic structure." The diffraction of neutrons by chromium is discussed in relation to a sinusoidal model without allowance for temperature effects. Differences were demonstrated between the diffraction patterns given by sinusoidal spiral and antiphase models. Some factors are discussed which must be allowed for in deducing the magnetic moments of chromium atoms from experimental data. (auth)

23612 ACTINIUM–BERYLLIUM EMITTERS. V. I. Fominykh and I. Ya. Yaritsyna. p.46-9 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

The basic characteristics of Ac-Be sources, of interest for metrological studies, were examined. The average calculated energy of these sources is 4.7 Mev; measurements with B counters containing paraffin cylinders yielded a value of 4.6 Mev. The sources present the advantages of a high specific neutron yield, low γ background and high isotropicity. The theoretical specific yield is 2.64×10^7 n/(sec Curie); the experimental finding was 2.25×10^7 n/(sec Curie). (TTT)

23613 APPLICATION OF THE ASSOCIATED PARTICLE METHOD TO THE MEASUREMENT OF THE YIELD OF NEUTRON SOURCES AND FLUXES. V. T. Shebolev. p.52-5 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

Experiments were carried out to establish whether the method based on recording the associated particles is suitable for the absolute measurement of the yield of neutron sources. The $T(d,n)^4He$ reaction, the yield of which reaches a maximum at an energy of about 110 kev of the bombarding neutrons at an interaction cross section of $\sigma = 5.1 \pm 0.1$ barn, was used in the experiments. It was found that the yield measurements are controlled by the

precision of the required linear and angular measurements and of the accelerating voltage. The above reaction may be used for calibration tests. (TTT)

23614 DESIGN, CONSTRUCTION AND EXAMINATION OF AN ~14 Mev NEUTRON SOURCE. V. T. Shebolev. p.55-8 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

A horizontal accelerator was designed and built for obtaining neutrons with an initial energy of ~14 Mev on the basis of the $T(d,n)^4He$ reaction. The apparatus included a high-frequency ion source for producing deuterium ions, the accelerating and analyzing systems and the target chamber with the detector. The gaseous D was prepared by the electrolysis of a 30% solution D_2SO_4 in D_2O; a proportional counter was used as detector. The neutrons obtained were monoenergetic with an isotropic distribution in the center of mass system and the yield could be changed from $\sim 10^4$ to 5×10^8 n/sec. The emitted neutrons could be conveniently determined on the basis of the associated α particles. (TTT)

23615 STUDIES FOR DETERMINING THE OPERATING CONDITIONS OF THE ACCELERATOR FOR CARRYING OUT THE $T(d,n)^4He$ REACTION AND FOR MEASURING THE NEUTRON YIELD. V. T. Shebolev. p.59-62 of "Novye Nauchno-Issledovatel'skie Raboty po Metrologii. Informatsionnyi Sbornik." Moscow-Leningrad, Izdatel'stvo Staidartov, 1964. (In Russian)

A low-voltage neutron generator was examined for determining the sources of error which arise in the determination of the neutron yield by means of the associated particle method. A Zr layer containing Zr-T was used as target, determining the average deuteron energy from the energy dependence of the cross section, $\sigma(E)$, of the $T(d,n)^4He$ reaction. The background effects were taken into consideration when counting the accompanying α particles, and corrections were made for the ~2.5-Mev neutrons arising from the $D(d,n)^3He$ reaction. The mean square error of the neutron yield measurement was found to be about 0.7%. (TTT)

23616 PHYSICS OF NUCLEAR KINETICS. G. Robert Keepin. Addison-Wesley Series in Nuclear Science and Engineering. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1965. 443p.

The intensive properties of neutrons are described, with particular attention to the physics of neutron-induced fission; and the macroscopic behavior of neutron populations in bulk media is treated, together with the implications for the dynamic behavior of reactors. Fast reactor kinetics is emphasized. (D.C.W.)

23617 SCATTERING OF "WARM" NEUTRONS FROM POLYETHYLENE. J. S. King and J. L. Donovan (Univ. of Michigan. Ann Arbor). 22p. (CONF-641004-10)

From American Physical Society, Chicago.

Neutron scattering by highly crystalline polyethylene was studied to determine if either multiple phonon or multiple scattering events significantly affect the observed spectra. "Warm" neutrons downscattered from a variable incident energy to a fixed final energy at 0.027 ev were used. Data were obtained at a 90° scattering angle on polyethylene samples held at 298, 125, and 95°K. The spectra obtained were compared with "cold" neutron results obtained by Danner, et al. (J. Chem. Phys., 40: 1417(1964)). The agreement was good below 200 cm^{-1} but became progressively poorer at higher frequencies. The frequency limit for the lowest acoustic mode predicted by the linear model agreed very closely with the value of 194 cm^{-1} observed in both neutron experiments. The maximum at 500 to 540 cm^{-1} was also in agreement with the second predicted limit. It was concluded that the two-phonon component is too small by perhaps a factor of three to account for the experimental points. (M.C.G.)

23618 LEAST SQUARE MATRIX METHOD FOR ANALYZING NEUTRON SPECTRA. H. M. Epstein, B. P. Fairand, and B. L. Schrock (Battelle Memorial Inst., Columbus, Ohio). 8p. (CONF-654-61)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

A matrix method for least-square error minimization on overdetermined response matrices in the determination of fast neutron spectra from activation measurements is presented. The matrix equations are given for several methods of finding neutron spectra. (D.C.W.)

23619 ULTRACOLD NEUTRONS AND THEIR POTENTIAL VALUE IN GRAVITATIONAL RESEARCH. Robert L. Forward (Hughes Research Labs., Malibu, Calif.). 20p. (CONF-641004-2)

From American Physical Society, Chicago.

The properties of very low energy (less than 10^{-5} ev) neutrons and the problems involved in the generation of an ultradense neutron gas suitable for experiments in gravitation are discussed. New methods for cooling neutrons below cryogenic temperatures are proposed that involve the use of moving, decelerating potential barriers to bunch the neutrons in a beam and slow them to any desired velocity. Either a traveling wave magnetic field or a series of moving neutron reflectors can be used. The Fermi exclusion principle presents an obstacle to the condensation of the ultracold neutrons into a dense form of matter, but it is possible that this effect will be bypassed by the creation of bosons, either through the formation of tetraneutrons (n^4) or through some type of collective interaction. Even assuming that a stable, dense neutron gas can be formed, it is shown that in order to generate a strong artificial gravitational field, even over a very small region, a copious neutron source such as a nuclear power plant will be required. (auth)

23620 SCATTERING OF FAST NEUTRONS BY SILICON AND SULFUR. Gus A. Petitt. 14p. (CONF-481-86)

From American Physical Society Annual Meeting, Jan. 1964, New York.

The elastic and inelastic scattering of neutrons by silicon and sulfur at 2.45 to 5.80 Mev was investigated. The measured angular distributions, cross sections, and excitation functions were compared with theoretical predictions. (D.C.W.)

23621 NEUTRON GENERATOR. Reuben Redstone, Peter Donald Lomer, Mervyn Hillier, James David London Hedley Wood, Walter Sidney Whitlock, and Philip Owen Hawkins (to United Kingdom Atomic Energy Authority). British Patent 980,947. Jan. 20, 1965. Filed June 30, 1961.

A pulsed neutron generator includes within a common sealed envelope an ion source consisting of two parallel-plate cathode members normal to a common axis with an anode member positioned between them and a target spaced from the ion source on the same axis to form a single-stage acceleration gap. A magnetic field is maintained in the ion source and extends deep into the acceleration gap so that the field lines over the entire distance between the cathode members are substantially parallel to the axis. The generator has a target assembly that facilitates removal of heat from the target area and that may be preloaded with tritium or deuterium to simplify manufacture. (A.G.W.)

23622 APPARATUS FOR CARRYING OUT A NUCLEAR REACTION. John Ellery Bounden (to United Kingdom Atomic Energy Authority). British Patent 981,279. Jan. 20, 1965. Filed Jan. 14, 1963.

A neutron generator relatively free of sputtering troubles and producing more than 10^9 neutrons/sec is enclosed within a sealed envelope. The envelope contains a zone for production of ions in a plasma, a target, and an extractor electrode forming a partition between the ion-production zone and the target. The extractor electrode has an aperture for passage of ions and is coated on the side facing the zone with a vitreous material. An electrical field accelerated ions from the extractor electrode toward the target. An electron stopper to stop secondary electrons emitted from the target and a screen to prevent plasma from reaching the electron stopper are provided. The favored neutron reactions are the DD and DT reactions, and a gas replenisher is provided within the envelope. (A.G.W.)

Nuclear Properties and Reactions

Refer also to abstracts 22282, 22286, 22696, 22801, 23146, 23209, 23312, 23313, 23355, and 23375.

23623 (CEA-R-2597) RELATIONS ENTRE LA RESONANCE NUCLEAIRE DU COBALT METALLIQUE ET SES PROPRIETES FERROMAGNETIQUES. (Relationship Between the Nuclear Resonance of Cobalt Metal and Its Ferromagnetic Properties). Jean-Noeel Aubrun (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1964. 79p. Dep.(mn).

Thesis submitted to Paris Univ., Orsay (France). Faculté des Sciences.

Theoretical study of nuclear magnetic resonance in ferromagnetic metals shows the dependence of ferromagnetic properties on this nuclear resonance. This results from a strong interaction between nuclei and magnetic electrons. The latter excite the nuclei, and, in Bloch walls, submit them to a r-f field much stronger than those directly applied. The parameters of the resonance are determined from wall movement and depend consequently on ferromagnetic constants. The theory is able to provide quantitatively some peculiar effects, specially those of a continuous magnetic field and of temperature. Experimental studies are performed on cobalt powders, and with theory. However one must take the skin-effect into consideration and accordingly adjust the theory. This requirement can explain some observed divergences, as well as the influence of particle size and magnetic field on the line shape. Data are obtained about some typical ferromagnetic properties of cobalt, when studying magnetic field effect, and this method is applicable to other ferromagnetic materials. In consideration of the peculiar characteristics of this nuclear resonance, which occurs without external magnetic field and whose line width is large, new models of spectragraphs have been realized and have permitted accurate measures of the line shape. The weak intensity of the signals obtained in some cases has induced the elaboration of an original method of extraction, whose theory and practical uses are described. The whole of this experiment reveals nuclear resonance as a strong way for the study of ferromagnetism, which is able to detect microscopic phenomenons, not easily accessible by classical methods. (auth)

23624 (CEA-R-2613) ANALYSE ET CONSTITUTION DU 1er JEU U–Pu (0.043% de Pu). (Analysis and Composition of the First U–Pu Charge (0.043 Per Cent of Pu)). Jean-Paul Brunet, Dominique de Lapparent, and Pierre Lourme (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). Jan. 1965. 51p. Dep.(mn).

Checking the homogeneity in the content of plutonium of 0.043% Pu–natural uranium alloy slugs was made by counting ^{240}Pu and ^{238}U spontaneous-fission neutrons. The purpose of the test was to select groups of slugs to be correctly associated into fuel rods for critical experiments. The general technique for spontaneous fissions counting, then elaboration of data in view of ranking the slugs are described. Results are given for this particular case. (auth)

23625 (HUX-2752-1) ANNUAL SUMMARY REPORT OF RESEARCH IN HIGH-ENERGY NUCLEAR PHYSICS. (Harvard Univ., Cambridge, Mass. Dept. of Physics). Dec. 30, 1964. Contract AT(30-1)-2752. 23p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Measurements are discussed concerning electron pairs produced at large angles in configurations in which intermediate virtual electrons are given large momenta by incident gamma radiation. The configurations are such that the correction for nuclear recoil caused by virtual electron scattering from the nucleus is minimized. Work on photoproduction of pion pairs on C, H, Be, Cu, and Al targets is also discussed. Work on production of polarized nuclear targets for study of spin dependence in nuclear scattering is reported. A satisfactory target was not developed during the report period. Results of bubble chamber experiments on photoproduction of mesons and hyperons at 0.5 to 5 Bev are reported. Results of studies concerning the production of π^0 and η^0 by negative pions on protons are also reported. Results of scattering experiments are reported which show that the electromagnetic form factors continue to fall with increasing 4-momentum transfer. Development of computer programs for interfacing on-line outputs of several high-energy physics experiments being performed at the Harvard Cyclotron and the Cambridge Electron Accelerator is reported. A time-sharing system called MONITOR was developed that permits the computer to serve several classes of users virtually simultaneously. (J.R.D.)

23626 (JINR-P-1995) RADIATSIONNYE SHIRINY SREDNIKH YADER. (Radiative Widths of Medium Nuclei). Kim Hi San, L. B. Pikelner, Kh. Sirazhet, and E. I. Sharapov (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1965. 8p. Dep.(mn).

The radiative widths of a number of neutron resonances for Zn, Mo, Nb, and Rb isotopes have been investigated with a pulsed reactor. In a plot of the radiative widths versus the number of neutrons N in a nucleus there is observed a maximum for N = 43 and 44 and a minimum for N = 38 to 40. (auth)

23627 (JINR-P-2007) DINAMICHESKAYA POLYARIZATSIYA DEITONOV V KRISTALLE LANTAN-MAGNIEVOGO NITRATA. (Dynamical Polarization of Deuterons in a Crystal of Lanthanum–Magnesium Nitrate). V. I. Lushchikov, Yu. V. Taran, and A. I. Frank (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1965. 7p. Dep.(mn).

The solid-effect method was applied to the polarization of deuterium in a monocrystal of lanthanum-magnesium nitrate with a frequency 37 Gc. A large amplification of the deuteron polarization at thermal equilibrium, that corresponds to the deuteron polarization 4.5, was found. (auth)

23628 (NRL-6186) DETERMINATION OF THE SPIN AND PARITY OF NUCLEAR EXCITED STATES BY THE EXPERIMENTAL MEASUREMENT OF TRIPLE CORRELATION IN $(p,\gamma\gamma)$ REACTIONS. C. R. Gossett and L. S. August (Naval Research Lab., Washington, D. C.). Feb. 12, 1965. 92p.

The measurement of triple correlations in $(p,\gamma\gamma)$ reactions to determine spin and parity of nuclear excited states is discussed. An experimental arrangement is described that allows the measurement of triple correlations with an exceptionally high efficiency and multiplicity (the capability of measuring many different correlations simultaneously). This improvement has been obtained primarily from the application of a three-crystal double sum-coincidence spectrometer. An explanation of the method and detailed descriptions of the physical apparatus, electronic circuitry, experimental procedures, and data analysis are given, including explanations of a number of deviations from normal in both the design and procedures. As an illustration of the effectiveness and limitations of the experimental arrangement, the results of an extensive triple correlation experiment on the $^{60}Ni(p,\gamma\gamma)^{61}Cu$ reaction are presented, with the conclusions regarding the spin and probable parity of six of the lowest-lying energy levels and a discussion of the applicability of certain nuclear models to this nucleus. (auth)

23629 (ORNL-3738) MEASUREMENT OF α, THE RATIO OF THE NEUTRON CAPTURE CROSS SECTION TO THE FISSION CROSS SECTION, FOR ^{235}U IN THE ENERGY REGION FROM 3.25 eV TO 1.8 Kev. G. deSaussure, L. W. Weston, R. Gwin, J. E. Russell, and R. W. Hockenbury (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 72p. Dep.; $3.00(cy), 2(mn) CFSTI.

The value of α (the ratio of the neutron capture cross section to the fission cross section) for ^{235}U has been measured over a neutron energy range extending from 3.25 ev to 1.8 kev. In addition, capture and fission cross sections have been measured from 3.25 to 25 ev. The experiment was performed with neutron time-of-flight facilities. A multiplate ^{235}U fission chamber, surrounded by a large liquid scintillator, was placed in the neutron beam. Gamma rays emitted when the uranium absorbed a neutron were detected with high efficiency by the scintillator, and if the absorption resulted in a fission, the fission fragments were detected by the fission chamber itself. The value of α was

derived from the ratio of the count rate of the scintillator in anticoincidence with the fission chamber to the count rate of the scintillator in coincidence with the fission chamber. Relative fission and capture cross sections were obtained from these count rates and from an auxiliary measurement of the incident neutron beam spectrum. Results are presented in graphical and tabular form. (auth)

23630 (RPI-328-20(p.42-6)) NEUTRON RESONANCE PARAMETERS FOR THE ISOTOPES OF HAFNIUM 30-400 ev. T. Fuketa, J. E. Russell, and R. W. Hockenbury (Rensselaer Polytechnic Inst., Troy, N. Y.).

Results of analyses of data from a series of neutron transmission experiments on Hf isotopes are presented. The Hf isotopes are mass numbers 176, 177, 178, 179, and 180. (J.R.D.)

23631 (RPI-328-20(p.53-4)) POLARIZATION OF PHOTONEUTRONS FROM O^{16}. F. Hanser, W. Bertozzi, S. Kowalski, W. Sargent, W. Turchinet, R. Fullwood, and J. Russell (Rensselaer Polytechnic Inst., Troy, N. Y.).

The polarization of photoneutrons from ^{16}O was measured at gamma-neutron angles of 45 and 90°. Data on the photoneutron polarization plotted as a function of neutron energy for three bremsstrahlung energy end points are included. (J.R.D.)

23632 (UCRL-11225) QUASI-PARTICLE INTERACTIONS IN EVEN-EVEN NUCLEI. Mannque Rho (Lawrence Radiation Lab., Univ. of California, Berkeley). Jan. 27, 1964. Contract W-7405-eng-48. 66p. Dep.(mn); $3.00 (cy), 2(mn) CFSTI.

The residual terms arising from the Bogoliubov-Valatin transformation are studied, and their roles in even-even spherical nuclei are examined by means of simple perturbation theory. It is argued that but for the uncertainty in the number of particles, the quasi-particle formalism simplifies the energy matrix even for complicated systems. The simplified equations are examined and certain conditions are found necessary in order that the calculations be consistent with experiments. The approximate formulas are applied to some 82-neutron nuclei, and the results show qualitative agreement with experiments. (auth)

23633 (UJV-1211/64) CIRCULAR POLARIZATION OF γ RAYS FOLLOWING THE CAPTURE OF POLARIZED NEUTRONS. J. Kopecky (Ustav Jaderného Výzkumu, Československá Akademie Věd, Řež (Czechoslovakia)). Jan. 1965. 63p. Dep.(mn).

The circular polarization of gamma radiation is measured, following the capture of polarized neutrons for five elements. The even-odd nucleus ^{33}S, used for the checking of the instrument, confirmed the spin value of the 3.22 Mev level. With the odd-odd nuclei ^{52}V, ^{60}Co, and ^{64}Cu, experimental information is obtained on the effect of the lowest resonances on the formation of cross section in the thermal region. At the same time, the most probable values of spins of the lowest excited levels to which compound nuclei deexcite by high-energy transition are determined. For ^{92}Zr the spin of the excited 2.35 Mev level is determined. (auth)

23634 DECAY OF Eu^{157} AND Tm^{174}. J. Kantele (Univ. of Helsinki), K. M. Broom, and D. M. Chittenden, II. Ann. Acad. Sci. Fennicae, Ser. A VI, No. 162, 1-16(1964).

The decay of 15.1-hr ^{157}Eu and the 5.2-min ^{174}Tm was investigated using scintillation spectrometers, radiochemical separations having been used in element identification and source preparation. Decay schemes are proposed incorporating 0.46- and 850-μsec isomeric states in the daughter nuclei ^{157}Gd and ^{174}Yb, respectively. The results are discussed in the framework of the Nilsson scheme and the pairing correlation model. (auth)

23635 NUCLEAR PAIRING FORCE AND SUPERCONDUCTIVITY WAVE FUNCTIONS. Alexander Lande (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 31: 525-47 (Feb. 24, 1965). (PUC-1964-147)

The extent to which the methods of superconductivity theory are reliable when applied to the calculation of the properties of deformed nuclei is examined numerically. The exact eigenstates for an even or odd number of particles moving in nine or fewer evenly spaced levels and interacting via a pairing force (whose magnitude is dictated by the observed odd-even mass differences) provide the basis for comparison. The following are examined: (1) the BCS-Bogoliubov approximations to the ground and excited states, (2) the modifications to account for blocking of levels by unpaired particles, (3) projection of that part of the wave function containing the correct number of particles, and (4) the dependence on the self-energy term ($-G\nu^2$). To block before solving the BCS equations does not appear to be warranted. Indeed for beta-decay hindrance factors, the least sophisticated method (1) is as adequate as the rest, coming to within 5–10% of the exact values. The calculation of spectra is considerably improved by projecting, but again only the ground state parameters need be used. None of the methods consistently approximate the occupation factors of the $(u_\alpha v_\beta + \sigma v_\alpha u_\beta)^2$ and $(u_\alpha u_\beta + \sigma v_\alpha v_\beta)^2$ type to better than 20% for $\sigma = -1$, and 10% for $\sigma = +1$. However, either blocking-without-projecting or projecting with the unblocked parameters are often equally satisfactory. The degree to which the small number of levels considered has a bearing on these results is examined. (auth)

23636 HALF-LIVES OF THE FIRST EXCITED STATES IN Hf^{178} AND Hf^{174}. H. Abou-Leila, N. N. Perrin, and J. Valentin (Universite de Paris, Orsay, France). Arkiv Fysik, 29: 53-9(1965).

The half lives of the $2+ \rightarrow 0+$ transitions in the ground-state bands of ^{178}Hf and ^{174}Hf were measured by means of a time-to-amplitude converter, as $(1.50 \pm 0.1)\ 10^{-9}$ sec and $(1.64 \pm 0.1)\ 10^{-9}$ sec, respectively. These results are discussed. (auth)

23637 AVERAGE LIFETIME OF THE Al^{27} NUCLEUS EXCITED TO 20 Mev. Borbala Gyarmati and Ede Koltay. At. Kozlemen., 6: 131-6(Dec. 1964). (In Hungarian)

The average lifetime of nucleus ^{27}Al excited to 20.5 Mev was estimated to 1.2×10^{-20} sec on the basis of the evaluation of the Ericson fluctuations appearing in the $^{25}Mg(d,\alpha)^{23}Na$ nuclear reaction. The theoretical value estimated on the basis of the evaporation model is 2.0×10^{-20} sec. (auth)

23638 ELASTIC SCATTERING OF 0.662-Mev PHOTONS FROM LEAD. E. Dahn (Institut fur Angewandte Radioaktivitat, Leipzig). Atomkernenergie, 10: 39-40 (Jan.-Feb. 1965). (In German)

The cross-section for the elastic scattering of 0.662-Mev photons from lead was measured at angles between 45 and 100°. The results are in good agreement with those presented by Mann in an earlier paper and with the calculations of Brown and Mayers. (auth)

23639 ROTATION AND BETA-VIBRATION INTERACTION IN THE RARE-EARTH EVEN NUCLEI. A. Sobiczewski (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 12: 757-60(1964).

The correction to the energy of the ground state rotational band levels of even nuclei, due to the interaction between these levels and the first beta-type excited state ($n_\beta = 1$), was obtained. The corresponding numerical calculations were made for ^{154}Gd, ^{156}Gd, ^{166}Er, and ^{168}Er, based on the Nilsson's model and taking into account the pairing forces. (L.B.S.)

23640 TERNARY FISSION OF U^{235} IRRADIATED WITH THERMAL NEUTRONS. M. K. Juric. Bull. Boris Kidrich Inst. Nucl. Sci., 15: 217-25(Oct. 1964).

The fission fragments of ^{235}U induced by thermal neutrons in enriched photonuclear emulsion insensitive to alpha particles were investigated. Besides collinear binary fission tracks in emulsion there are events in which three prongs come out from one center ("star"). There are 1.5% such events per binary fission. The lengths of and angles between the prongs in the microscope field of view were measured on about 500 stars. The mean values of the angles suggest that these stars can not be ascribed

simply to elastic scattering of binary fission fragments. Analysis of stars of which all three prongs lay in the microscope field of view and the track length exceeded 2.8 μ, showed that there were 12 stars which could not be ascribed to elastic scattering of binary fission fragments. Hence, the numerical ratio of ternary to binary fissions is minimum 1:4000. (auth)

23641 DIFFERENTIAL CROSS SECTIONS OF (p,p) AND (p,p′) SCATTERING FROM SEVERAL ODD A NUCLEI IN THE ENERGY RANGE OF 6 TO 7.5 Mev. Jun Kokame and Kiyoji Fukunaga. Bull. Inst. Chem. Res., Kyoto Univ., Suppl., 1-25(Feb. 1965).

A compiled table of numerical differential cross sections of elastic and inelastic scattering of protons from several odd-even nuclei is presented. Measurements were carried out using a 105-cm cyclotron. The incident energy of protons was changed by stacked aluminium foils in the energy range from 6 to 7.5 Mev. Targets nuclei were ^{11}B, ^{13}C, ^{19}F, ^{25}Mg, ^{27}Al, ^{31}P, and ^{35}Cl. The purpose of the experiment was to investigate the reaction mechanisms and the relation to the structure of nuclei. Discussions on the results are presented. (auth)

23642 DIFFERENTIAL CROSS SECTIONS OF (α,α) AND (α,α') SCATTERING FROM B^{11}, C^{12}, C^{13}, O^{16}, Ne^{20}, Mg^{24}, Si^{28} AND P^{31}. Jun Kokame, Kiyoji Fukunaga, Hitoshi Nakamura, and Nobuyuki Inoue. Bull. Inst. Chem. Res., Kyoto Univ., Suppl., 26-40(Feb. 1965).

Numerical differential cross sections of elastically and inelastically scattered alpha particles are presented. Target nuclei were ^{11}B, ^{12}C, ^{13}C, ^{16}O, ^{20}Ne, ^{24}Mg, ^{28}Si, and ^{31}P. The energy of the incident particles is about 28.5 Mev and the beam of alpha particles was obtained from a 105-cm cyclotron. (auth)

23643 DIFFERENTIAL AND INTEGRAL CROSS SECTIONS OF THE (p,α) AND (d,α) REACTIONS ON SOME LIGHT NUCLEI. Takuji Yanabu, Sukeaki Yamashita, Teruo Nakamura, Kunio Takamatsu, Akira Masaike, Shigeru Kakigi, Dai Ca Nguyen, and Kiyohiko Takimoto. Bull. Inst. Chem. Res., Kyoto Univ., Suppl., 41-67(Feb. 1965).

Alpha emitting reactions induced by protons and deuterons were investigated. Protons with an energy near 7.5 Mev and deuterons with an energy near 15 Mev were produced by a cyclotron. Alpha particles leaving the residual nuclei in their ground or low-lying excited states were detected by a proportional counter, a scintillation counter, or a solid state detector. Differential and integrated cross sections are given for the following reactions; (p,α) reactions on ^{19}F, ^{23}Na, ^{27}Al, ^{31}P, and ^{39}K, and (d,α) reactions on ^{12}C, ^{14}N, ^{16}O, ^{19}F, ^{20}Ne, ^{27}Al, ^{31}P, and ^{32}S. (auth)

23644 DIFFERENTIAL AND INTEGRAL CROSS SECTIONS OF THE REACTIONS $C^{12}(d,\alpha)B^{10}$ AND $O^{16}(d,\alpha)N^{14}$ IN THE DEUTERON ENERGY RANGE FROM 15 Mev TO 20 Mev. Takuji Yanabu, Sukeaki Yamashita, Teruo Nakamura, Kunio Takamatsu, Akira Masaike, Shigeru Kakigi, Dai Ca Nguyen, and Kiyohiko Takimoto. Bull. Inst. Chem. Res., Kyoto Univ., Suppl., 68-85(Feb. 1965).

Angular distributions of alpha particles were obtained when the ^{12}C nucleus was bombarded by deuterons with energies from 15.1 to 19.7 Mev, leaving the residual nucleus, ^{10}B, in its ground, first, third, and fourth excited states. Also obtained were the angular distributions of alpha particles when the ^{16}O nucleus was bombarded by deuterons with energies ranging from 14.9 to 19.6 Mev, leaving the residual nucleus, ^{14}N, in its ground and second excited states. Numerical values of the differential cross sections are listed for these reactions and the integral cross sections calculated from these results are also given. (auth)

23645 ON THE SEPARATION METHOD FOR THE NUCLEAR MANY-BODY PROBLEM. M. Razavy and S. J. Stack (Univ. of Alberta, Edmonton). Can. J. Phys., 43: 605-18(Apr. 1965).

A method of calculation of the nuclear reaction matrix is proposed in which the interaction is divided into two parts. The long-range part of the interaction together with the kinetic energy forms the unperturbed Hamiltonian, and the short-range interaction is treated as a perturbation. The separation distance is so chosen that the perturbation produces no energy shift, but modifies the many-body wave function. For the special case in which the outer part of the interaction is sufficiently weak, a plane-wave approximation is used for the unperturbed wave function, with the result that the diagonal elements of the reaction matrix are given by the first Born approximation of the long-range part of the potential. An iteration scheme is set up to compute the dividing point of the interaction. Such properties of nuclear matter as saturation, binding energy, and rearrangement energy are discussed in terms of the separation distance and its derivatives. Finally, this method is compared with those of Moszkowski and Scott and Bethe. (auth)

23646 THE GAMMA-RAY SPECTRUM OF $^{16}N(\beta^-\gamma)^{16}O$ OBSERVED WITH A LITHIUM-DRIFTED GERMANIUM SPECTROMETER. P. A. Crean and T. K. Alexander (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 43: 721-3(Apr. 1965). (AECL-2170)

The gamma radiation from the levels at 6.13 and 7.12 Mev in ^{16}O following β decay of ^{16}N was observed with a lithium-drifted germanium spectrometer. Analysis of the time spectrum gave a half life of 7.5 ± 0.1 seconds, in agreement with previous determinations. The levels in ^{16}O are separated by 987 ± 3 kev. A precise measurement of the energy of the state at 7.12 Mev in ^{16}O is of considerable astrophysical interest. (F.S.A.)

23647 CONVERSION ELECTRON RAYS ACCOMPANYING THE DECAY OF TUNGSTEN-177 INTO TANTALUM-177. Bertrand Ader, Nils Perrin, and Jacques Valentin (Universite de Paris, Orsay, France). Compt. Rend., 260: 865-8(Jan. 18, 1965). (In French)

Forty-seven transitions in the capture decay of ^{177}W were detected and measured, and the multipolarities of eight of them were determined. (tr-auth)

23648 A DOUBLE "STRIPPING" REACTION FOR THE REACTION OF TRITIUM ON OXYGEN-16 IN RELATION WITH THE STRUCTURE OF OXYGEN-18. Claude Maguin (Universite, Lyon). Compt. Rend., 260: 1149-52(Jan. 25, 1965). (In French)

A formalism of direct interaction in the Butler-Born approximation is applied to the study of the $^{16}O(t,p)^{18}O$ reaction. The use of a wave function with configuration mixing for ^{18}O did not improve the results; this suggested a more complex reaction. (tr-auth)

23649 NUCLEI AND NUCLEAR REACTIONS. O. R. Frisch (Cambridge Univ., Eng.). Contemp. Phys., 6: 81-93(Dec. 1964).

A brief survey on nuclear forces, decay, reactions and structures is presented, with consideration of the techniques used to investigate these areas. Reactors, thermonuclear processes, and cosmic radiation are briefly discussed. (D.C.W.)

23650 ABSORPTION CROSS-SECTION MEASUREMENTS AND RESONANCE PARAMETERS FOR Pu-239. K. G. Ignat'ev and I. V. Kirpichnikov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Euro Nucl., 2: 77-8(Feb. 1965).

An instrument consisting of an arrangement of four NaI(Tl) scintillation counters was used for direct measurements of the ^{239}Pu absorption, fission, and total cross sections, at neutron energies of 7 to 550 ev. The quantities measured were the γ-yield from the specimen (N_γ), the yield of secondary fission neutrons (N_F), and the transmission of the specimen. Experimental curves of N_f and N_γ are presented, calculations were made of Γ_f/Γ_γ for resonances up to 90 ev, and positions of the strongest resonances from 100 to 300 ev were determined. The results were found to agree with other experimental results. (L.B.S.)

23651 ON NUCLEAR EXCITATION AND FORMATION ENERGIES. PART IV. A. K. Dutta, B. Pal, P. Ganguly, and D. Banerjee (Calcutta Univ.). Indian J. Phys., 38: 518-21(Oct. 1964).

Neutron-proton exchange energy values are compared

with excitation energies of nuclei, using 1st and 3rd excitation energies for strongly bound odd and even mass nuclei. A general relation describing the variation of excitation energies and neutron-proton exchange energies with mass numbers is given, and values calculated from it are compared with experimental values. Previously obtained formulas for the nuclear binding energy are modified. (M.J.T.)

23652 NUCLEAR ENERGY AND NUCLEAR CHARACTERISTICS. PART V. A. K. Dutta (Calcutta Univ.). Indian J. Phys., 38: 522-6(Oct. 1964).

The forms of the two potential energy curves F(Z) and F(I), where I is the excess number of neutrons, which determine the nuclear formation energy and excitation energy, are discussed in relation to mass number and magic nuclei. Asymmetric nuclear fission, isotopic abundances, number of isobaric nuclei, and number of isotopes of a given element are related to these variations. Nuclear models, the process of nuclear growth, nuclear symmetry maintenance, and group formation of nuclei are considered. (M.J.T.)

23653 ON NUCLEAR STRUCTURE AND NUCLEAR MOMENTS. PART VI. A. K. Dutta (Calcutta Univ.). Indian J. Phys., 38: 527-30(Oct. 1964).

The process of structural growth of nuclei is used in an attempt to explain the correlation between nuclear orbital momentum and magnetic and quadrupole moment. Experimental findings on the total orbital momentum and the magnetic dipole moment are considered; their values are tabulated, and correlations between them and proton, neutron, and mass numbers are pointed out. (M.J.T.)

23654 QUASI-CRYSTALLINE STRUCTURE AND INTERRELATION BETWEEN NUCLEAR MOMENTS. PART VII. A. K. Dutta (Calcutta Univ.). Indian J. Phys., 38: 531-4(Oct, 1964).

The possibility is considered of interrelating magnetic and orbital moments on the basis of a quasicrystalline structure, which considers larger nuclei as composed of elementary or primary nuclei. Nuclei with atomic number to 5 are considered elementary. Orbital-momentum and spin-momentum quantum numbers of protons and neutrons are obtained for several nuclei and compared with experimental values. (M.J.T.)

23655 NUCLEAR QUADRUPOLE INTERACTIONS IN ALKALI HALIDE MOLECULES. T. P. Das (Univ. of California, Riverside) and M. Karplus. J. Chem. Phys., 42: 2885-91(Apr. 15, 1965).

The field gradients at the positive- and negative-ion nuclei in alkali halide molecules were analyzed taking account of overlaps between the atomic orbitals for the electrons within the ions and covalent binding through the transfer of electrons from the negative to positive ions. Explicit numerical calculations were performed for the case of the KCl molecule. It is shown that the inclusion of overlap effects, in addition to pure ionic contributions considered earlier, alters the field gradient in the right direction to improve the agreement with the observed field gradient at the chlorine nucleus. Charge-transfer covalency, on the other hand, increased the discrepancy with experiment. The field gradient at the positive-ion nucleus was also affected quite significantly by the inclusion of overlap effects. (auth)

23656 LIGHT RADIOISOTOPES OF PLATINUM FORMED IN THE INTERACTIONS OF TANTALUM WITH NITROGEN IONS. S. M. Qaim (Univ. of Liverpool). J. Inorg. Nucl. Chem., 27: 759-66(Apr. 1965).

Decay characteristics of light radioisotopes of platinum formed in the interactions of tantalum with 140-Mev ^{14}N ions were investigated. Values for the half lives and gamma energies were determined by scintillation spectrometry. Most of the γ rays reported to be associated with the daughter iridium isotopes were also confirmed. (P.C.H.)

23657 DETERMINATION OF THE RESONANCE INTEGRAL OF ^{55}Mn. P. W. F. Louwrier and A. H. W. Aten, Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). J. Nucl. Energy, Pt. A & B, 19: 267-70(Apr. 1965).

A method for determining the resonance integral of ^{55}Mn is described, which is based on measurements of cadmium ratios for thin manganese foils in $MnSO_4$ solution baths. The results are presented along with previously published calculated and experimental values. (L.B.S.)

23658 CALORIMETRIC DETERMINATION OF THE MEAN β-ENERGY AND HALF-LIFE OF PROMETHIUM-147. E. J. Wheelwright, D. M. Fleming, and F. P. Roberts (General Electric Co., Richland, Wash.). J. Phys. Chem., 69: 1220-3(Apr. 1965).

The mean β energy of the ^{147}Pm decay was calorimetrically measured at periodic intervals extending over a 1-yr period. Two independently prepared 1000-C sources of highly purified Pm_2O_3 were examined. The results obtained were self-consistent and in excellent agreement with measurements made on the same sources by an independent scientist using a second calorimeter. Values of 0.3330 ± 0.0005 w/g of ^{147}Pm and 2.620 ± 0.005 years for the β-decay energy and the half life, respectively, are believed to be very reliable values. (auth)

23659 STUDIES OF REACTIONS $p + {}^{11}B \rightarrow 3\alpha$ AND $d + {}^{10}B \rightarrow 3\alpha$. C. Lemeille (CEN, Saclay, France), D. Manesse, L. Marquez, N. Saunier, and J. Steyaert. J. Phys. (Paris), 26: 1-4(Jan. 1965). (In French)

The energy spectra of the alpha particles from the two reactions were measured, using the Saclay tandem accelerator. The energy spectra of the first reaction can be quantitatively explained if it is assumed that the reaction goes through the first excited state of ^{8}Be. For the second reaction, agreement can be obtained if the first and the second excited states of ^{8}Be are taken into account. (auth)

23660 NONLINEAR RESPONSE OF A SYSTEM OF NUCLEAR SPINS WITH AN EXTERNAL EXCITATION. J. P. Cohen-Addad (Institut Fourier, Grenoble, France). J. Phys. (Paris), 26: 19-25(Jan. 1965). (In French)

A nuclear spin system is considered, the interaction energy of which is characterized by a correlation time which is very long or infinite (the motion of the nuclei with non-zero spin is small or completely negligible). The transverse macroscopic magnetization $M_x(t)$ of this system is expanded as a series up to the third order of the amplitude of the driving field. A component $\delta_\gamma(\omega)\, e^{i\omega t}$ describing two quanta transitions, and the partial saturation of the linear response corresponds to the third-order term, which depends on a four-variable correlation function. An example is studied. (auth)

23661 SYMMETRIC AND ASYMMETRIC FISSION OF U^{238} INDUCED BY HELIUM IONS. Masao Seki (Kyushu Univ., Fukuoka, Japan). J. Phys. Soc. Japan, 20: 190-208 (Feb. 1965).

The energetics of helium-ion-induced fission of ^{238}U were investigated, using a back-to-back solid state detector system. Measurements were made at 90 and 160° cms and at bombarding energies of 27.8, 30.4, 32.6, 34.2, and 35.6 Mev. It was found that the position of the asymmetric fission peak in the kinetic energy contour diagram and the most probable values of E_L, E_H, and E_K are nearly independent of the excitation energy of the compound nucleus. From comparison with results obtained at lower energies, it is concluded that the average total kinetic energy in symmetric fission increases with the excitation energy of the fissioning nucleus but the peak in the mass yield distribution is approximately independent of the excitation energy. Some systematics are derived for the average total kinetic energies. The average excitation energy of fragments remains nearly constant in symmetric fission but not in asymmetric fission as the excitation energy of the fissioning nucleus increases. The anisotropies for symmetric and asymmetric fission seem to be consistent with theoretical predictions. (auth)

23662 NUCLEAR HYPERFINE STRUCTURE IN W^{182}. Naomoto Sikazono, Hidekuni Takekoshi, and Tokio Shoji (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 20: 271-5(Feb. 1965).

The Moessbauer effect was studied in the 100-kev $(2^+ \rightarrow 0^+)$ transition in ^{182}W. Metallic tantalum was used as the source and metallic tungsten, WO_3 powder, and WO_3 single crystals as absorbers. For the absorbers of

WO_3 powder and single crystals a quadrupole interaction was observed. The value of $eQV_{zz}(1 - R_A) = -3.5 \times 10^{-6}$ ev was obtained. The electric field gradient at the tungsten nucleus in the WO_3 lattice was estimated to be 1.7×10^{18} volt/cm^2 and the asymmetric parameter η was proved to be approximately zero. (auth)

23663 SATURATION BEHAVIOR OF NUCLEAR MAGNETIC RESONANCE IN FERROMAGNETIC COMPOUND MnNiSb. Hiroyoshi Suzuki and Eiji Hirahara (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 20: 294-5(Feb. 1965).

Previous experimental results on the line shapes of NMR absorption in ^{121}Sb and ^{123}Sb are discussed; the ^{123}Sb susceptibility is a mixture of dispersion and absorption parts, whereas that of ^{121}Sb is pure dispersion. Redfield's formula for the dispersion part in the saturation region is given, and expressions for the peak at resonance of the first derivative and the half width are obtained. Calculated and experimental results for the variation of the peak height of the first derivative of ^{121}Sb with r-f field power are compared. Results on the ^{123}Sb dispersion mode seem to be qualitatively similar. (M.J.T.)

23664 MULTIPLE COULOMB EXCITATION OF NUCLEI. I. Ya. Berson. Latvijas PSR Zinatnu Akad. Vestis, Fiz. Tek. Zinatnu Ser., No. 6, 3-8(1964). (In Russian)

The Coulomb excitation probabilities of a pure rotational band in even-even nuclei are evaluated as functions of the parameters q and ξ. It is found that the excitation probabilities are very sensitive with regard to the parameter ξ. (auth)

23665 NUCLEAR FISSION. PART I. NUMBER OF PROMPT NEUTRONS EMITTED FROM FISSION FRAGMENTS. Takao Honda (Yamanashi Univ., Japan). Mem. Fac. Liberal Arts Educ., Yamanashi Univ., No. 14, 104-8 (1963). (In Japanese)

The behavior of prompt neutrons in nuclear fission is studied, using the cigar-shaped fragments. When the numbers of prompt neutrons are plotted against the masses of the fission fragments, it is found that the average number of prompt neutrons emitted from the lighter fission fragment is larger than that from the heavier one when the fission is nearly symmetric, whereas the reverse phenomenon occurs when it is asymmetric. These phenomena cannot be explained with the liquid-drop model. For the shape of the nucleus immediately before the fission, a model composed of two cigar-shaped prolate spheroids, which osculate with each other on the major axis, is assumed. As an example, the average number of prompt neutrons emitted is estimated, for the fission of ^{235}U by thermal neutrons, from the excitation energies of the fission fragments calculated on the basis of the present model. It is found that the theoretical curve (the average number of prompt neutrons vs the fragment mass) is similar to the experimental. The phenomena mentioned above can thus be explained qualitatively with the present model. (NSA of Japan)

23666 ANGULAR DISTRIBUTION FOR THE T(d,n)He^4 REACTION AT 1 AND 3 Mev DEUTERON ENERGY. A. Paulsen and H. Liskien (EURATOM, Geel, Belg.). Nucl. Phys., 56: 394-9(1964). (EUR-2149.e)

The angular distribution for the T(d,n)^{4}He reaction was remeasured at 10° intervals from 0 to 130° for deuteron energies of 1 and 3 Mev. The calculated uncertainties are within ±2.0% and ±3.0%. The experimental results were fitted to Legendre polynomials and comparisons with earlier measurements are presented. (auth)

23667 ODD-EVEN EFFECT IN THE NUCLEAR LEVEL DENSITY AND SUPERFLUID MODEL OF NUCLEI. Vittorio Canuto and Leopoldo S. Garcia-Colin (Centro de Investigation y de Estudios Avanzados del I.P.N., Mexico City). Nucl. Phys., 61: 177-93(Jan. 1965).

The superfluid model of nuclei as formulated by Belyaev is used to account for the observed variation of the nuclear level density among odd, odd-mass, and even nuclei. (auth)

23668 THE (γ,α) REACTION IN Cu, Ag, In AND Au. L. Meneghetti and S. Vitale (Universita, Genoa and EURATOM-CNEN, [Ispra, Italy]). Nucl. Phys., 61: 316-20 (Jan. 1965).

Alpha particles photoproduced at 90° from Cu, Ag, In, and Au were detected by silicon junction counters. Yields and spectra were obtained at a maximum bremsstrahlung energy of 35 Mev. A comparison with the statistical model suggests the presence of direct effects in alpha photoproduction from In and Au. (auth)

23669 THE EMISSION OF PROTONS FROM LIGHT NEUTRON-DEFICIENT NUCLEI. Joachim Jaenecke (Technische Hochschule and Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Phys., 61: 326-41(Jan. 1965).

The properties of the processes which lead to the emission of protons from light neutron-deficient nuclei are discussed. These processes are in particular proton decay, double proton decay and β-delayed emission of protons and di-protons. Masses of light nuclei with $Z \leq 14$ were calculated and a limit of stability with regard to the emission of protons is given. Candidates for double proton decay are the following light even-Z nuclei: ^{12}O, ^{16}Ne, ^{19}Mg, and possibly ^{23}Si. The β-delayed emission of protons should occur subsequently to the positron decays of ^{5}C, ^{17}Ne, ^{19}Mg, and ^{20}Mg. Emission of weak proton groups may also follow the positron decays of (^{12}O), ^{13}O, ^{21}Mg, ^{24}Si, and ^{25}Si. Several of these proton groups have been observed. (auth)

23670 THE ^{93}Nb(d,p)^{94}Nb REACTION AND THE LOW-LYING STATES OF ^{94}Nb. Raymond K. Sheline (Florida State Univ., Tallahassee), Robert T. Jernigan, James B. Ball, Kumar H. Bhatt, Yeong E. Kim, and Jean Vervier. Nucl. Phys., 61: 342-51(Jan. 1965). (ORNL-P-78)

A large number of states up to approximately 3.3 Mev were observed in the reaction ^{93}Nb(d,p)^{94}Nb utilizing magnetic analysis of the protons. A quintuplet of levels near the ground state is identified as the low-lying part of the configuration $(\pi g_{9/2})(\nu d_{5/2})^3$. An interpretation of the data is made using the recently established (p,n) residual interaction in ^{92}Nb to calculate the low-lying levels of ^{94}Nb. The energies of the observed levels and the intensities of the corresponding proton groups are well reproduced by the calculations. (auth)

23671 NUCLEAR STRUCTURE AND PAIRING CORRELATIONS FOR THE HEAVY ELEMENTS. H. J. Mang, J. K. Poggenburg, and J. O. Rasmussen (Univ. of California, Berkeley). Nucl. Phys., 64: 353-78(Mar. 1965).

The advent of BCS calculations for deformed nuclei has brought extensive progress in understanding many nuclear properties. With the aid of fast and versatile computer facilities a number of previously-made simplifying assumptions have been tested. By use of delta-force matrix elements between Nilsson eigenfunctions, instead of a constant-G pairing force, some feeling for the nature of fluctuations in Δ_ν values and their variation as the systems are filled is gained. By carrying the usually-neglected $\bar{G}_{\nu\nu'}$ matrix elements of Belyaev a generally uniform lowering of Nilsson levels is observed as the system is filled. The systematic effects on variational energies and average configuration mixing caused by projecting fixed-particle terms from BCS wave functions (PBCS) is studied. The variation was performed on the fixed-particle expression (FBCS). The FBCS method gives the lowest possible energies for a variational solution of the projected BCS form. The FBCS method is found always to lead to nontrivial solutions no matter how weak the residual force strength; the abrupt transition between superfluid and normal states of the nuclear fluid, predicted by the BCS method, is thus found to be a spurious result. The FBCS method always gives more configuration mixing than PBCS. The PBCS energies are close to FBCS in the region of high pairing correlation but are worse where pairing correlation is lower. This tendency is reflected strikingly in the odd-even mass differences, where the PBCS method gives differences much too large in the region of low pairing correlation. Most of the simpler methods are found to predict too-high level densities for odd-proton systems, relative to the FBCS method. (auth)

23672 NOTE ON THE Pt AND Hg MASS-197 ISOMERS. A. J. Haverfield, H. T. Easterday, and J. M. Hollander (Univ. of California, Berkeley). Nucl. Phys., 64: 379-92(Mar. 1965). (UCRL-11607)

The decays of ^{197}Pt, ^{197m}Pt, ^{197}Hg, and ^{197m}Hg into the levels of ^{197}Au were examined with use of semiconductor detector spectrometers. Gamma-ray spectra were recorded with lithium drifted germanium detectors, and internal conversion coefficients were measured with an electron-gamma spectrometer employing both silicon and germanium detectors. These conversion coefficients were determined: the 191 kev transition in ^{197}Au following ^{197}Pt decay, $\epsilon_K = 0.69 \pm 0.07$, $K/L = 5.2 \pm 0.6$; the 346 kev transition in ^{197m}Pt, $\epsilon_K = 3.9 \pm 0.4$, $K/L = 1.8 \pm 0.2$. The 191 kev transition is interpreted as having multipolarity M1 + (≈28%) E2, and the 346 kev transition is M4. Details of the decay schemes are discussed. From the observed decay patterns of ^{197}Pt and ^{197m}Pt, spin assignments $\frac{1}{2}^-$ and $\frac{13}{2}^+$ are made for these isomers, respectively. The spin of the 268 kev level in ^{197}Au is interpreted as $\frac{3}{2}^+$, consistent with the core-excitation interpretation of these levels by Braunstein and de-Shalit. The reported existence of a level in ^{197}Au at 155 kev was not confirmed, and a reported weak 407 kev radiation from the decay of ^{197m}Hg was not observed. The absolute transition probability of the 202 kev E2 radiation connnecting the 279-kev ($\frac{5}{2}^+$) and 77-kev ($\frac{1}{2}^+$) states is discussed, within the framework of the de-Shalit model and also that of Kisslinger and Sorensen. (auth)

23673 PERTURBATIONS OF THE 197 kev-γ ANGULAR DISTRIBUTION THROUGH INNER FIELDS IN GASEOUS AND METALLIC MEDIA. O. Klepper and H. Spehl (Universitat, Freiburg i. B.). Nucl. Phys., 64: 393-400 (Mar. 1965). (In German)

Perturbations of the 197-kev γ angular distribution in different media were explored using the recoil associated with the excitation of the 197-kev level of ^{19}F by protons. The excited nuclei recoiling from a very thin CaF_2 target were stopped in various gases (Ne, Ar, air) or solids (Cu, Au, Ag, Pt, Ni, C). The angular distribution in the experiments with gases was found to be isotropic. This strong perturbation is attributed to a time-dependent hyperfine structure interaction. The time dependence is caused by transitions in the fluorine electron shell during atomic collisions in the gas. The attenuation coefficient G_2 for ^{19}F nuclei stopped in metals were found to be larger than 0.20 except for nickel. (auth)

23674 THE DECAY OF Eu^{150} (13 h) AND Eu^{150} (≈5 y). M. Guttman, E. G. Funk, and J. W. Mihelich (Univ. of Notre Dame, Ind.). Nucl. Phys., 64: 401-19(Mar. 1965). (COO-498-41)

The decay of the two isomeric states of ^{150}Eu was studied using scintillation and magnetic spectrometers and coincidence and directional correlation techniques. In addition, the gamma spectrum of 5 yr ^{150}Eu was investigated with a lithium-drifted germanium detector. The nucleus ^{150}Eu (13 hr) decays to both ^{150}Sm and ^{150}Gd. The decay to ^{150}Sm proceeds via electron capture and a 1242-kev positron branch (0.3%) to the ground state and vis electron capture branches to levels at 334(2^+), 740(0^+), 1047(2^+), 1165(2^+), 1256(0^+) and 1970 (1^-,2^+) kev. A level at 1764 kev is possible. Spin and parity assignments were established by internal conversion coefficient and gamma-gamma directional correlation measurements. Gamma transitions of the following energies (and relative intensities) were observed: 334(8.3), 406(6.2), 714(0.4), 831(0.9), 922(0.8), 1165(0.7), 1230(0.2), 1636(0.14), and 1970(0.3) kev. A 1010-kev β^- branch (87% of all decay) proceeds to the ground state of ^{150}Gd. The most likely assignment for the short-lived ^{150}Eu is 1^- or possibly 0^-. The decay of ^{150}Eu (≈ 5 y) proceeds to levels in ^{150}Sm at 334(2^+), 773(4^+), 1072(3^-), 1357(5,3), 1505, 1642, 1822, 1973, 2021 and 2120 kev. A level at 1278 kev is also possible. Gamma transitions of the following energies (and relative intensities) were observed in the decay: 298(<1), 334(100), 439(89), 506(5.4), 516(1.9), 584(60), 738(12.9), 750(8.8), 831, 869(4.8), 1049(9.0), 1171(3.0), 1248(4.8), 1309(1.6), 1347(4.5), 1488(2.2), and 1639(1.3) kev. In addition, several other weaker transitions were observed. Gamma-gamma directional correlations were measured for several prominent cascades. The observed log ft values for the electron-capture branches are most consistent with an assignment of 5^- or 4^- for the long-lived ^{150}Eu. (auth)

23675 LOW-ENERGY PHOTOFISSION OF U^{238}. T. Kivikas and B. Forkman (Univ. of Lund, Sweden). Nucl. Phys., 64: 420-32(Mar. 1965).

Symmetric and asymmetric photofission yields of ^{238}U, defined by ^{117}Cd and ^{139}Ba, were studied at energies near the photofission threshold. The experimental yields were fitted to theoretical yield curves. From these fits values of the fission barrier height B_f and the fission barrier form parameter E_p were obtained for both symmetric and asymmetric fission. The similarity of the fission barrier heights for the two modes of fission favors the picture that the valley-to-peak ratio in the mass distribution is determined after the nucleus has passed the saddle point. The E_p value obtained is in agreement with estimates from spontaneous fission data, showing that the barrier for threshold fission and for spontaneous fission are directly related. (auth)

23676 LIFETIME OF THE 103 kev LEVEL IN $_{93}Np^{237}$. J. L. Wolfson and W. R. Dixon (National Research Council, Ottawa). Nucl. Phys., 64: 433-48(Mar. 1965).

The half life of the 103-kev level in ^{237}Np was found to be $(8 \pm 4) \times 10^{-11}$ sec. The experimental method utilizes the Doppler shift of 26-kev conversion electrons emitted from the 103-kev level following α decay of ^{241}Am. These electrons are examined in a high resolving power beta spectrometer. The distribution of electrons is compared with the distribution obtained when the conversion electrons are successively decelerated and accelerated by an electrostatic field near the source. A finite lifetime results in a net acceleration of the conversion electrons. A method of analysis was developed which enables the lifetime to be measured in terms of the resulting distortion of the original distribution. (auth)

23677 ENERGY LEVELS OF THE Sc^{49} NUCLEUS. L. M. El-Nadi, Omar E. Badawy, A. El-Sourogy, D. A. E. Darwish, and V. Y. Gontchar (Atomic Energy Establishment, Cairo). Nucl. Phys., 64: 449-57(Mar. 1965).

The energy levels of the ^{49}Sc nucleus of energies higher than 10.5 Mev were determined through the study of the ^{48}Ca(p,nγ)^{48}Sc reaction. The gamma spectra were measured in the proton energy range 1.2-2.5 Mev. The γ-ray yield curves for the 0.37, 0.50, and 0.76 Mev gamma lines corresponding to the de-excitation of the second to the first excited states, and the third and fourth to the second excited states of ^{48}Sc, respectively, were determined from the measured spectra. About 90 resonances were observed in this excitation energy range, corresponding to excited levels in the compound nucleus ^{49}Sc. The energies and relative intensities of the resonance levels were determined. Their positions were confirmed by measuring the ^{48}Ti activity produced by the β-decay of the ^{48}Sc nucleus. The ^{49}Sc level density is compared with that of the ^{41}Ca nucleus. (auth)

23678 ENERGY LEVELS, CONFIGURATION MIXING AND PROTON NEUTRON INTERACTION IN THE Zr REGION. N. Auerbach and I. Talmi (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., 64: 458-80(Mar. 1965).

A shell model analysis of the interaction between configurations of protons in the $2p_{\frac{1}{2}}$ and $1g_{\frac{9}{2}}$ orbits is presented. Matrix elements of the effective interaction are determined which accurately reproduce a larger number of experimental data. These are binding energies and positions of excited states in ^{90}Zr, ^{91}Nb, ^{92}Mo, and ^{93}Tc. The interaction of a $2d_{\frac{5}{2}}$ neutron with $2p_{\frac{1}{2}}$ and $1g_{\frac{9}{2}}$ protons is determined from the levels of ^{90}Y and ^{92}Nb. This interaction is used to calculate the spectra of nuclei with protons in the $2p_{\frac{1}{2}} - 1g_{\frac{9}{2}}$ shell and neutrons in the $2d_{\frac{5}{2}}$ orbit. Good agreement is obtained between calculated and experimental ehergies. In particular, the calculated energy of the isomeric state in ^{93}Mo and the energies in the following cascade agree very well with the experimental energies. (auth)

23679 THE PRODUCTION OF Tb^{149} FROM GOLD IN THE Gev REGION. E. Bruninx (CERN, Geneva). Nucl. Phys., 64: 481-5(Mar. 1965).

The cross section for the proton-induced reaction (^{197}Au, ^{149}Tb) was measured between 7 and 27.3 Bev. The range in gold of a few α emitters was determined. (auth)

23680 THE $Al^{27}(\gamma,n)Al^{26m}$ CROSS SECTION. M. N. Thompson (Univ. of Melbourne), J. M. Taylor, B. M. Spicer, and J. E. E. Baglin. Nucl. Phys., 64: 486-96(Mar. 1965). (IS-1001)

The yield curve of the reaction $^{27}Al(\gamma,n)^{26m}Al$ was determined by measuring the short-lived positron activity from the first excited state of ^{26}Al. Analysis of the yield curve by the least structure method reveals a cross section consistent with, but with more detail than, previous measurements, there being at least 14 resonances between threshold and 23 Mev. Consistency is shown to exist between the energies of these peaks and the energies of those found in photoneutron and photoproton energy spectra from ^{27}Al reported from other laboratories. The reaction threshold is found to be 13.27 ± 0.05 Mev. The integrated cross section from threshold to 25 Mev is found to be 31 ± 5 Mev · mb. Interpretation of the cross section is discussed. (auth)

23681 E1-TRANSITIONS FROM 532-kev VIBRATION LEVELS IN Er^{167}. Lothar Funke, Heinz Graber, Karl-Heinz Kaun, Horst Sodan, and Lothar Werner (Zentralinstitut fur Kernphysik, Rossendorf, Ger.). Nucl. Phys., 64: 497-501(Mar. 1965). (In German)

The decay of ^{167}Tm was investigated by means of coincidence measurements. New gamma transitions were found with energies of 270 and 325 kev and intensities were compared with the intensity of the 532-kev transition of 1.3×10^{-3} and 2.5×10^{-2}, respectively. Estimating the K conversion coefficients the character of both transitions was determined to be E1. The hindrance factors for E1 transitions of the $(K_0 - 2)$ vibrational states in ^{165}Ho, ^{167}Er, and ^{187}Re were calculated, the order of magnitude being 10^3 to 10^5. (auth)

23682 TOTAL REACTION CROSS SECTIONS IN THE MASS RANGE 45 TO 65. George F. Dell, W. D. Ploughe, and H. J. Hausman (Ohio State Univ., Columbus). Nucl. Phys., 64: 513-23(Mar. 1965).

The (p,n) cross sections were measured on targets of ^{45}Sc, ^{51}V, ^{55}Mn, ^{63}Cu, and ^{65}Cu by activation techniques over the approximate energy range of 3.5 to 6.75 Mev. The proton charged-particle cross sections were measured at 6.75 Mev for the same targets. Neglecting the compound elastic scattering, values of total reaction cross section at an incident bombarding energy of 6.75 Mev were found to be 433 ± 57, 646 ± 43, 505 ± 43, 497 ± 41 and 613 ± 29 mb respectively. These values were found to be less than an optical model calculation except for the case of ^{65}Cu where the measured total reaction cross section is greater than the optical model value. (auth)

23683 THE $N^{14}(p,n)O^{14}$ NEUTRON THRESHOLD. Hsinmin Kuan and J. R. Risser (Rice Univ., Houston, Tex.). Nucl. Phys., 64: 524-8(Mar. 1965). (TID-20775)

The threshold of the reaction $^{14}N(p,n)^{14}O$ was determined to be 6358.8 ± 3.0 kev. The $^{13}C(p,n)^{13}N$ threshold, taken to be 3235.3 ± 1.5 kev, was used as calibration. The $^{27}Al(p,n)^{27}Si$ threshold was measured for comparison and was found to be 5803.1 ± 4.5 kev. (auth)

23684 GENERALIZED HARTREE-FOCK METHOD AND ROTATIONAL STATES. Mitsuo Sano and Masamichi Wakai (Osaka Univ.). Nucl. Phys., 67: 481-503(June 1965).

The generalized Hartree-Fock method is applied to a description of rotating nuclei. This method gives a self-consistent description of the rotational motion based on the cranking model and effects of rotation on the pair correlation. The Coriolis force prevents the formation of coupled pairs. Thus there is an upper bound of the angular momentum such that a nucleus can be superconducting. The reduction of the energy gap results in an increase in the moment of inertia. The stability of rotational states is also discussed. The emphasis here is that, even if low-lying excited states with small angular momenta are stable, for sufficiently large angular momentum the Coriolis force leads to the instability of rotational states. (auth)

23685 REMARKS ON THE THEORY OF DIRECT REACTIONS. B. Buck and J. R. Rook (Nuclear Physics Lab., Oxford). Nucl. Phys., 67: 504-16(June. 1965).

The effect of coupling to channels other than those representing scattering in the initial and final states is investigated. Necessary and sufficient conditions are obtained for such couplings to be small and the extent to which these conditons are valid is examined for (d,p), (t,p), and (d,α) reactions. It is concluded that only (d,p) reactions are likely to be well described by the usual DWBA theory which ignores these couplings. Plausible arguments are given to account for the empirical agreement between experiment and the cut off DWBA theory. (auth)

23686 THE $Li^7(He^3,\alpha)Li^6$ REACTION BETWEEN 1.3 AND 5.5 Mev. P. D. Forsyth and R. R. Perry (Rice Univ., Houston, Tex.). Nucl. Phys. 67: 517-28(June 1965). (TID-21367)

The differential cross sections for the $^7Li(^3He,\alpha)^6Li$ reactions leading to the ground and 2.18-Mev states of ^6Li were measured as a function of bombarding energy between 1.3 and 5.5 Mev at laboratory angles of 8, 90, and 165°. Angular distributions were measured at bombarding energies of 1.81, 2.14, 2.50, 2.98, 3.64, 4.36, and 5.13 Mev. The total cross sections for these reactions were obtained by integration of the angular distributions. The reactions appear to proceed largely via direct interaction processes although there is some evidence for compound nucleus formation at the lower energies. The angular distributions for the two alpha-particle groups are strikingly dissimilar especially at the higher energies, suggesting that different reaction mechanisms are involved. These possible reaction mechanisms are discussed. (auth)

23687 NUCLEAR FISSION AS A MARKOV PROCESS. R. Ramanna, R. Subramanian, and Raju N. Aiyer (Atomic Energy Establishment, Trombay, India). Nucl. Phys., 67: 529-41(June 1965).

Starting from the assumption of a random transfer of nucleons between the two sides of a fissioning nucleus, during the time from saddle point to scission, a new theory of fission is developed to show that the mass distribution in low, intermediate and high energy fission can be explained on arguments based on the ground state properties of nuclei. The theory is extended to show that the shape of the deformation energy-mass curves follows as a direct consequence of the equilibrium conditions which determine the mass distributions and the gap in the "zig-zag" curves is essentially due to the proton transfers. The time of fission is shown to be of the order of 500 nucleonic times in spontaneous and low energy fission and results from the properties of the transition matrix. The theory is also able to explain the small range of the threshold energies of fission of heavy nuclei and the formation of a symmetry axis early in the process. (auth)

23688 INELASTIC PROTON SCATTERING. I. Ar^{40} AND Ca^{40}. W. S. Gray, R. A. Kenefick, and J. J. Kraushaar (Univ. of Colorado, Boulder). Nucl. Phys., 67: 542-64 (June 1965). (COO-535-538)

Inelastic proton scattering from ^{40}Ar at bombarding energies of 14.1 and 16.9 Mev and ^{40}Ca at 14.6 and 17.3 Mev was studied with solid state counters. Angular distributions for the elastic scattering, fourteen inelastic groups from ^{40}Ar, and twelve from ^{40}Ca were measured in the angular range 20 to 150°. The inelastic angular distributions were analyzed in terms of the distorted-wave Born approximation. A surface derivative form factor corresponding to first-order collective excitations was employed. On the basis of the DWBA analysis, spin assignments were made to a number of levels in each nucleus. (auth)

23689 INELASTIC PROTON SCATTERING. II. Ti^{50} AND Fe^{54}. W. S. Gray, R. A. Kenefick, and J. J. Kraushaar (Univ. of Colorado, Boulder). Nucl. Phys., 67: 565-76(June 1965). (COO-535-539)

Inelastic proton scattering from ^{50}Ti at 18.2 Mev and ^{54}Fe at 17.9 Mev was studied with protons from the variable-energy cyclotron. A tandem accelerator was employed in a supplementary search with 11.5-Mev protons for levels in ^{50}Ti. Angular distributions for the elastic scattering, five inelastically scattered groups from ^{50}Ti and eight from ^{54}Fe, were obtained with the cyclotron. Spin assignments to a number of levels were made on the basis of a distorted-wave Born approximation analysis of the inelastic angular distributions, in which a form factor corresponding to the first-order collective excitations was employed. (auth)

23690 RELATIVE TRANSITION STRENGTHS FOR LEVELS OF C^{11}. M. L. Roush, A. A. Jaffe, A. S. Figuera, and W. F. Hornyak (Univ. of Maryland, College Park). Nucl. Phys., 67: 577-91(June 1965).

A measurement of the γ-ray branching of the levels at 6.35, 6.90, and 7.50 Mev in ^{11}C is described. The states of ^{11}C were populated by the reaction ^{9}Be(^{3}He,n)^{11*}C and the resulting de-excitation γ-rays studied. Time-of-flight techniques were used to select neutron groups leading to the states in question, and γ-ray spectra were recorded in coincidence with each individual group. The spectra were analyzed to determine the dominant branches present and the following results were obtained: 6.35 → 0 (65 ± 5%), 6.35 → 2.00(35 ± 5%), 6.90 → 0 (89 ± 3%), 6.90 → 4.32 (11 ± 3%), 7.50 → 0 (25 ± 5%) and 7.50 → 2.00 (75 ± 5%). Based upon the similarity of branching, it appears likely that these states in ^{11}C correspond to analog states in ^{11}B at energies of 6.81, 7.30, and 7.99 Mev, respectively, for which similar branching ratios were observed. The observed γ-ray branching is consistent with J^π(6.35 Mev) = $\frac{1}{2}^+$, $\frac{3}{2}^+$ or $\frac{5}{2}^-$, J^π(6.90 Mev) = $\frac{3}{2}^+$, $\frac{5}{2}^+$ or $\frac{7}{2}^-$ and J^π(7.50 Mev) = $\frac{1}{2}^+$ or $\frac{3}{2}^+$. A comparison with the analogue states in ^{11}B lends support for J^π(6.35 Mev) = $\frac{3}{2}^+$, J^π(6.90 Mev) = $\frac{1}{2}^+$ and J^π(7.50 Mev) = $\frac{1}{2}^+$ or $\frac{3}{2}^+$. The decay of the 7.50-Mev state is shown to indicate a nucleon configuration of $(1p_{\frac{3}{2}})^3(1p_{\frac{1}{2}})(1d_{\frac{5}{2}})$ and is also discussed in terms of a possible ^{7}Be + α cluster configuration. (auth)

23691 MIXTURE OF HIGH-ENERGY CONFIGURATIONS IN THE DIPOLE STATES OF O^{16}. Saburo Fujii (Univ. of Virginia, Charlottesville). Nucl. Phys., 67: 592-608(June 1965).

In a calculation of the effect of higher configurations on the dipole states of ^{16}O, the eigenstates which have been obtained by Brown et al. with the particle-hole model are regarded as the unperturbed states. The admixture of high-lying configurations in the dipole states and the ground state is considered to second order. The energy shifts of the dipole states and the correction to the dipole matrix elements due to the configuration mixing are calculated, using a delta-function for the shape of the residual interaction. In the calculation, a momentum-dependence of the interaction strength is taken into account. The matrix elements of the residual interaction are reduced to a simple form through the relations between X coefficients and Racah coefficients, derived by Rose et al. It is found that the dipole states are lowered because of the configuration mixing and the sum of the squared dipole matrix elements over the five states is reduced by about 20% in magnitude although this result depends on the values chosen for the strength of the residual interaction and the energies of the single particle states. Finally, the calculated results are compared with the experimental data and the limit of validity of the zero-range approximation for the residual interaction is discussed. (auth)

23692 NUCLEAR SPECTROSCOPY OF Ba^{133m}. J. E. Thun, S. Toernkvist, F. Falk, and H. Snellman (Uppsala Univ.). Nucl. Phys., 67: 625-30(June 1965).

The decay of the 38.9 h isomer of ^{133}Ba was investigated. The energy of the $d_{\frac{5}{2}} \rightarrow s_{\frac{1}{2}}$ transition was determined by conversion electron measurements to 12.29 ± 0.04 kev and the L subshell ratios of the same transition were found to be 100/9.6/3.1. The half life of the 12.3-kev level was measured to 8.1 ± 2.0 ns. The K conversion coefficient and the K/(L + M) ratio of the 276-kev $h_{\frac{11}{2}} \rightarrow d_{\frac{5}{2}}$ transition were measured with the result: $\alpha_K(276) = 3.45 \pm 0.20$ and $K/(L + M) = 2.55 \pm 0.10$. The pairing plus quadrupole force model seems to explain the experimental data quite well. (auth)

23693 INELASTIC INTERACTIONS OF PIONS AND PROTONS WITH COMPLEX NUCLEI AT 5-30 Gev/c. P. L. Jain, H. C. Glahe, J. D. Rinaldo, and P. D. Bharadwaj (State Univ. of New York, Buffalo). Nucl. Phys., 67: 641-53 (June 1965).

A total of more than 2000 interactions in nuclear emulsion initiated by pions and protons of four different primary energies (between 5–30 Bev/c) were examined to study the general characteristics of stars produced in heavy nuclei. The analysis consists of the frequency as well as the angular distribution of shower particles, the correlation of $\langle n_h \rangle$ with n_s and $\langle n_s \rangle$ with n_h, the integral distribution of n_h and the variation of lightly and heavily ionized tracks with the primary energy. (auth)

23694 INTERNAL BREMSSTRAHLUNG FROM ^{6}He. J. K. Bienlein and Frances Pleasonton (Oak Ridge National Lab., Tenn. and Universitat, Erlangen, Ger.). Nucl. Phys., 68: 17-35(June 1965). (ORNL-P-789)

The spectrum of internal bremsstrahlung from the superallowed beta emitter ^{6}He was measured using a NaI scintillation spectrometer. The shape of the experimental spectrum agrees with the theory of Knipp, Uhlenbeck and Bloch for energies greater than 0.3 Mev. In this decay, Coulomb corrections are of little significance; thus, the results can be interpreted as confirming the fundamental concept of internal bremsstrahlung as a process in which the electron exists first in a virtual state and then goes to its final state by emitting a photon. (auth)

23695 STATES OF F^{16} EXCITED IN THE REACTION $O^{16}(p,n)F^{16}$. J. A. R. Griffith (Univ. of Birmingham, Eng.), C. J. Batty, R. S. Gilmore, and G. H. Stafford. Nucl. Phys., 68: 36-48(June 1965).

The neutron spectra produced at 0° from the reaction ^{16}O(p,n)^{16}F were measured, using time-of-flight techniques, for 30- and 50-Mev incident protons. The neutron groups found are attributed to reactions proceeding to the ground state and excited states of ^{16}F at 1.30 ± 0.05, 4.20 ± 0.05, 6.16 ± 0.05, 7.3 ± 0.3, 9.26 ± 0.05, 11.1 ± 0.1, 11.7 ± 0.1 and 19.5 ± 0.3 Mev. A comparison is made with the excited states of ^{16}N and the known T = 1 levels of ^{16}O. (auth)

23696 VIBRATIONAL STATES OF ODD-MASS NUCLEI BY THE QUASI-PARTICLE METHOD. William P. Beres (Massachusetts Inst. of Tech., Cambridge). Nucl. Phys., 68: 49-85(June 1965). (MIT-2098-69)

The properties of the low-lying energy levels of an odd-mass nucleus in the vibrational region are investigated using the quasi-particle method. A non-pairing (long-range) type of interaction is assumed to act between the nucleons. This interaction is expanded in multipoles, and diagonalizations are carried out in two different approaches: the quasi-boson plus quasi-particle scheme, which imagines that the lowest levels of the adjacent even nucleus are well described as quasi-boson states to which an odd quasi-particle may be coupled; and the three quasi-particle scheme which treats directly the odd-mass nucleus as an assemblage of quasi-particles. The wave functions generated are used to obtain electric transition rates and sum rules. (auth)

23697 EXCITATION OF COLLECTIVE STATES BY THE INELASTIC SCATTERING OF 14 Mev NEUTRONS. P. H. Stelson, R. L. Robinson, H. J. Kim, J. Rapaport, and G. R. Satchler (Oak Ridge National Lab., Tenn.). Nucl. Phys., 68: 97-140(June 1965). (ORNL-P-916)

The differential cross sections for the inelastic scattering of 14-Mev neutrons to low-lying collective states were measured for Bi, Pb, Sb, Sn, Cd, Zn, Ni, Cr, S, P, Si, Al and Mg. The inelastically scattered neutrons were separated from the elastically scattered neutrons by a time-of-flight system which had an energy resolution of 450 kev for 14-Mev neutrons. The absolute cross sections were determined to an accuracy of 20% over the angular

range from 20 to 130°. The cross sections obtained for excitation of collective quadrupole and octupole states are compared to the distorted-wave theory for direct interactions. It is found that the experimental shapes of the differential cross sections are in reasonable agreement in most cases with those predicted by theory. The nuclear deformation parameters, β_λ are extracted and these are compared both to the available electromagnetic β_λ values and to β_λ values obtained from other direct-interaction experiments. (auth)

23698 BETA-SPECTRUM SHAPE FACTOR OF P^{32}. J. Lehmann (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Nucl. Phys., 68: 141-4(June 1965).

The beta spectrum shape of ^{32}P was measured with an intermediate-image beta spectrometer; the results were compared with those obtained elsewhere. The average of the various results on the spectrum shape factor yields a slope of 9% $(mc^2)^{-1}$ from 300 to 600 kev and about 1% from 600 to 1650 kev. (auth)

23699 INTERNAL CONVERSION IN Fe^{57} FROM THE MÖSSBAUER EFFECT IN IRON. R. H. Nussbaum (Portland State Coll., Ore.) and R. M. Housley. Nucl. Phys., 68: 145-52(June 1965).

The conversion coefficient of the 14.4-kev Mössbauer transition in ^{57}Fe was determined from the effective nuclear resonance cross section of a thin natural iron foil placed in a saturating magnetic field. Near natural line widths were obtained with a single line source with precisely known resonant fraction. The total conversion coefficient of 9.0 ± 0.4 is in agreement with recent values from nuclear spectroscopy. (auth)

23700 ANALYSIS OF NUCLEAR SCATTERING AT LOW ENERGY BY THE OPTICAL MODEL. J. Picard (Service de Physique Nucleaire a Basse Energie, Saclay, France). Nucl. Phys., 68: 153-60(June 1965). (In French)

The optical model is used to analyze the data on elastic and non-elastic scattering and the polarization of protons and neutrons of 14 to 17 Mev energy scattered on ^{59}Co, ^{64}Cu, ^{68}Zn and ^{109}Ag and of 22 to 24 Mev energy scattered on ^{27}Al, ^{56}Fe, ^{116}Sn and ^{209}Bi. The real value of the central potential is given as a function of the incident energy and of the symmetry term of Lane. (auth)

23701 OBSERVATION OF A SECOND K = ½ BAND IN $_{94}Pu^{239}$. D. W. Davies and J. M. Hollander (Univ. of California, Berkeley). Nucl. Phys., 68: 161-9(June 1965). (UCRL-11707)

The gamma spectrum of 2.3-day ^{239}Np was studied with high-resolution lithium-drifted germanium spectrometers, and twelve previously unreported gamma rays of low intensity were identified. Ten of these are characterized as the de-excitation spectrum of a K = ½ band based at 469.8 kev in ^{239}Pu. The decoupling parameter of this band is found to be 0.48. A comparison is made of the experimental and theoretical photon relative transition intensities, and reasonable agreement is obtained for the case: $K_1 = \frac{1}{2}$, $b_{E1} = 0$. The properties of this band are consistent with those expected for Nilsson state $\frac{1}{2}^-[501]$. Estimates of the log ft values of ^{239}Np beta decay to levels of the new band are made and are discussed in terms of the states involved. (auth)

23702 RADIOACTIVITY OF U^{232}. G. Bertolini, F. Cappellani, G. Restelli, and H. L. Scherff (CCR, Euratom, Ispra, Italy). Nucl. Phys., 68: 170-6(June 1965).

The alpha, gamma and internal conversion electron spectra of ^{232}U were studied by semiconductor detectors. The L/M ratios for the 58- and 128-kev transitions and K, L and M conversion coefficients for the 128-kev gamma ray were determined. (auth)

23703 WIDTH OF THE 4.931 Mev LEVEL IN Si^{29}. S. J. Skorka, T. W. Retz-Schmidt, H. Schmidt, J. Morgenstern, and D. Evers (Universitat, Hamburg). Nucl. Phys., 68: 177-90(June 1965).

The radiative width of the 4.931-Mev, $\frac{3}{2}^-$ state in ^{29}Si was measured by a nuclear resonance fluorescence scattering experiment. The reaction $^{28}Si(d,p\gamma)^{29}Si$ served as a Doppler-broadened gamma source. Pulsed-beam time-of-flight techniques were used to eliminate effects due to the considerable neutron background from (d,n) reactions in the target. The experiment yielded $\Gamma = 0.57 \pm 0.09$ ev corresponding to a ground state transition strength of $|M|^2(E1) = 6.72 \times 10^{-3}$ Weisskopf units. The upper limit for the width of the 6.379-Mev $\frac{1}{2}^-$ state was found to be $\Gamma(\frac{1}{2}^-) \leq 2.0$ ev, corresponding to a ground state strength of $|M|^2(E1) \leq 6.72 \times 10^{-3}$ Weisskopf units. (auth)

23704 Li^6 PHOTODISINTEGRATION. E. B. Bazhanov, A. P. Komar, A. V. Kulikov, and E. D. Makhnovskii (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Phys., 68: 191-208(June 1965).

The excitation function of reactions with a neutron yield up to energies $E_\gamma = 60$ Mev is determined. Besides the known maximum in the region from 7 to 17 Mev, two broad maxima in the energy region $E_\gamma > 19$ Mev are noted on the curve of dependence of the total cross section of these reactions on E_γ. Real reactions with the emission of charged particles are established and the energy spectra of these particles are determined. Relative yields of the reactions are evaluated. A substantial contribution (≈30 mb · Mev) of the $^6Li(\gamma,t)^3He$ reaction to the total cross section for the absorption of gamma quanta by the ^6Li nucleus is registered. The energy region of the most intense absorption of gamma quanta by the ^6Li nucleus is established ($E_\gamma = 20$ to 30 Mev, $\sigma_0 = 45$ mb · Mev). The experimental value of the integral cross section for the photodisintegration of the ^6Li nucleus in the energy region $E_{thr} \leq E_\gamma \leq 60$ Mev does not exceed the minimum cross section calculated by the dipole sum rule (at $X = 0$ $\sigma_0 = 90$ mb · Mev). (auth)

23705 ENERGY LEVELS OF Y^{90} FROM THE $Y^{89}(d,p)Y^{90}$ REACTION. E. W. Hamburger and A. I. Hamburger (Universidade, Sao Paulo, Brazil). Nucl. Phys., 68: 209-20 (June 1965).

The nucleus ^{89}Y has a closed shell of 50 neutrons, so that the $^{89}Y(d,p)$ reaction explores the single-particle neutron states in the next shell. The protons in ^{89}Y couple to spin ½, therefore for each neutron single-particle state two close-lying levels are expected, corresponding to the two possible orientations of the proton spin relative to that of the added neutron. The experiment was performed with 15-Mev deuterons from the University of Pittsburgh cyclotron and employed magnetic analysis of the reaction products, which were detected in nuclear emulsions. Angular distributions corresponding to 26 levels of ^{90}Y were compared with DWBA curves and spectroscopic factors extracted. The $2d_{\frac{5}{2}}$, $2d_{\frac{3}{2}}$ and $3s_{\frac{1}{2}}$ doublets were easily identified by their angular distributions, but doubt remains as to the localization of other doublets, in particular the $h_{\frac{11}{2}}$ which was reported in a previous publication. The doublets can be used as a measure of the residual interaction of the outside $p_{\frac{1}{2}}$ proton of ^{89}Y and the added neutron. A comparison is made with shell model calculations of the level energies. (auth)

23706 ELASTIC SCATTERING OF COMPOUND PARTICLES BY NUCLEI. V. M. Strutinskii (Kurchatov Atomic Energy Inst., Moscow). Nucl. Phys., 68: 221-30(June 1965).

The black-nucleus model for the elastic scattering of compound particles is formulated with the aid of a boundary condition for the wave function. The differential scattering cross section, thus obtained, fits experimental data in a wide range of angles. (auth)

23707 SPIN-ORBIT COUPLING IN (d,pγ) STRIPPING REACTIONS. H. W. Barz, K. Hehl, C. Riedel, and J. Slotta (Central Institut for Nuclear Research, Rossendorf, Ger.). Nucl. Phys., 68: 231-40(June 1965).

The correlation function of the (d,pγ) reaction is calculated by means of the DWBA for the case of an optical potential with spin-orbit coupling. The captured neutron has the orbital angular momentum $l_n = 1$. Contrary to the case of a spin-independent optical potential the correlation function for γ rays emitted perpendicularly to the reaction plane is no longer proportional to the differential cross section. As a special example, DWBA calculations

for the reaction $C^{12}(d,p\gamma)C^{13}$ (second excited state) are performed. (auth)

23708 THREE α-PARTICLE DECAY OF C^{12}. J. D. Bronson, W. D. Simpson, W. R. Jackson, and G. C. Phillips (Rice Univ., Houston, Tex.). Nucl. Phys., 68: 241-69(June 1965). (TID-21363)

The reaction $^{11}B(p,2\alpha)^4He$ was studied at proton bombarding energies of 2.0, 2.65, 3.25, 3.73, 4.00, 5.08, and 5.64 Mev. These energies excite several resonant states in ^{12}C. The kinematics of the reaction were completely determined by detecting in coincidence two of the three final α particles in solid-state detectors. This determination of the kinematics permitted discrimination between sequential two-body decay and direct three-body decay. The reaction mechanism was found to be sequential two-body decay involving the ground and the broad first-excited states of ^8Be, with events involving the latter showing strong interference effects. These interference effects were attributable to the identity of the three final particles and to the ambiguity of the order of their emission. Not more than 5% of the experimental cross section could be attributed to the direct three-body decay mechanism; indeed, the contribution from the direct process is probably much smaller than the quoted 5%. Hence, the conclusion must be that, for ^{12}C with an excitation energy between 17 and 21 Mev, the decay mechanism is predominantly sequential two-body decay. Also the total cross section for this reaction is of the order of 100 to 200 mb; thus it is comparable to the geometric cross section. These two facts imply that, in this energy region, ^{12}C has a strong cluster configuration of an α particle plus a ^8Be nucleus in either the ground or the first-excited state. (auth)

23709 NUCLEAR STRUCTURE EFFECT IN THE INTERNAL CONVERSION PROCESS OF THE 81-kev TRANSITION IN Cs^{133}. B. N. Subba Rao (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., 68: 270-2 (June 1965).

The results of the measurement of the angular correlation of the 358-kev gamma ray K conversion electron of the 81-kev transition in ^{133}Cs are reinterpreted in the light of the recent recognition of the sign reversal of the interference particle parameter $b_2(e_2m_1;\lambda)$. (auth)

23710 PROTON-GAMMA ANGULAR CORRELATION MEASUREMENTS FOR $C^{13}(d,p\gamma)C^{14}$. J. M. Lacambra, D. R. Tilley, N. R. Roberson, and R. M. Williamson (Duke Univ., Durham, N. C.). Nucl. Phys., 68: 273-86(June 1965).

Proton-gamma angular correlation measurements were made for the $^{13}C(d,p)^{14}C$ reaction through the 6.09, 6.72, and 7.34-Mev states of ^{14}C at a deuteron bombarding energy of 3.7 Mev. The angular correlations were measured in the reaction plane with the proton counter on the stripping peak. Plane wave stripping theory was used in the analysis. The 6.09-Mev state angular correlation is isotropic, consistent with a pure $l_n = 0$ stripping process. The results for the 6.72 and 7.34-Mev states confirm the spin and parity assignments 3^- and 2^-, respectively, preferred on the basis of other experiments. All three angular correlations are symmetric about the recoil axis, and the correlation coefficients for the 6.72-Mev state are within 25% of the plane wave predictions. A 1.25-Mev gamma transition between the 7.34 and 6.09-Mev states was observed in the coincidence measurements. Branching ratios for the gamma rays associated with the de-excitation of the 7.34-Mev state were determined to be $\Gamma_{7.34}/\Gamma_{6.72} \leqq 0.22 \pm 0.07$ and $\Gamma_{1.25}/\Gamma_{6.72} = 0.5 \pm 0.2$. (auth)

23711 MEASUREMENTS OF THE INTERNAL CONVERSION COEFFICIENT RATIOS BY A SUM COINCIDENCE TECHNIQUE USING A SOLID STATE DETECTOR. D. R. Brundrit and S. K. Sen (Univ. of Manitoba, Can.). Nucl. Phys., 68: 287-97(June 1965).

A recently proposed sum coincidence technique, for the direct measurement of the ratios of internal conversion coefficients of cascade transitions, has been shown to yield values for these ratios which are in excellent agreement with those obtained by other methods. This new method is independent of the relative intensities of the cascade transitions and of the half life of the parent isotope. Cascade transitions in the levels of ^{75}As and ^{131}Cs have been studied. The ratios of the total internal conversion coefficients for cascades from the 401-kev level in ^{75}As were found to be: $\alpha_{121}/\alpha_{280} = 5.5 \pm 0.6$; $\alpha_{136}/\alpha_{265} = 4.0 \pm 0.3$. The value obtained for the ratio of the K conversion coefficients of the 124 kev–496 kev cascade in ^{131}Cs was 65 ± 5. Measurements on the K/(L + M) ratios for the 124, 216, 373, and 496-kev transitions in ^{131}Cs yielded the values: $(K/(L+M))_{124} = 2.6 \pm 0.2$, $(K/(L+M))_{216} = 3.1 \pm 0.3$, $(K/(L+M))_{373} = 4.6 \pm 0.5$, and $(K/(L+M))_{496} = 6.1 \pm 0.5$. (auth)

23712 THE RELATION BETWEEN THE REAL PARTS OF THE NUCLEON AND THE DEUTERON OPTICAL POTENTIALS. F. J. Bloore (Cambridge Univ., Eng.). Nucl. Phys., 68: 298-304(June 1965).

A relation is given between the real parts of the optical model potentials for nucleons and deuterons in infinite nuclear matter. These potentials are expressed in terms of the nucleon-nucleon potential using a formalism in which the identity of the constituent particles is taken into account in a properly antisymmetric way. It is confirmed that the potential experienced by a deuteron of incident energy E is almost twice the potential experienced by a nucleon of incident energy $\frac{1}{2}E$. When reasonable internucleon force parameters are used, the theoretical nucleon potential turns out to be rather too small. (auth)

23713 THE 6-kev TRANSITION IN Ta^{181}. Arthur H. Muir, Jr. (North American Aviation Science Center, Thousand Oaks, Calif.). Nucl. Phys., 68: 305-14(June 1965).

A detailed study was made of the 6-kev E1 transition in ^{181}Ta. Delayed coincidence measurements showed that the 6-kev γ ray is in coincidence with the 152.5-kev γ ray in ^{181}W decay. From K x ray-6-kev γ ray coincidence measurements the total conversion coefficient is found to be $\alpha_6 = 46 \pm 8$, while the K-capture fraction is determined to be 0.63 ± 0.05. The transition energy is measured as 6.2 ± 0.1 kev and the branching to the 159-kev level is $(7.7 \pm 2.5) \times 10^{-4}$. The present measurements using the coincidence technique are in agreement with the previous electron and γ-ray spectrometer measurements and confirm the ^{181}W decay scheme previously suggested. The conclusion is drawn that the 6-kev transition occurs between a level at 6-kev and the ground state, and thus that the γ ray should be suitable for Mössbauer effect experiments. (auth)

23714 CIRCULAR POLARIZATION OF EXTERNAL BREMSSTRAHLUNG FROM ^{210}Bi BETA RAYS. Mary E. Cunningham (Univ. of Oregon, Eugene). Nucl. Phys., 68: 315-24(June 1965).

The degree of circular polarization of the external bremsstrahlung produced by the beta rays from ^{210}Bi was measured by the Compton scattering technique. The results are consistent with an electron longitudinal polarization of 0.731. (auth)

23715 STUDY OF THE DECAY OF Cs^{134} WITH A HIGH RESOLUTION Ge(Li) γ-RAY SPECTROMETER. R. A. Brown and G. T. Ewan (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Nucl. Phys., 68: 325-36(June 1965).

The γ-ray spectrum of ^{134}Cs was studied with a 3.5 mm deep by 18 mm diameter Ge(Li) γ-ray spectrometer. The conversion line spectrum was also studied in a high resolution β-ray spectrometer and the K conversion coefficients of the transitions measured using a mixed source of ^{134}Cs and ^{137}Cs. The energies in kev, relative intensities in percent per disintegration, and dominant multipolarities of the γ-transitions are: 475.26 (1.5%, E2); 563.11 (8.3% E2); 569.24 (14.3%, M1); 604.64 (98.0%, E2); 795.80 (88.0%, E2); 801.80 (8.8%, E2); 1038.46 (1.0%, M1+ E2); 1167.65 (2.0%, E2); 1364.97 (3.4%, E2). The data are consistent with levels in ^{134}Ba at $0(0^+)$, $604.6(2^+)$, $1167.7(2^+)$, $1400.4(4^+)$, $1643.0(3^+)$, and 1969.6 kev (4^+). There is no evidence for previously reported levels at 1570 and 1773 kev. (auth)

23716 ABSTRACT CROSS SECTION MEASUREMENTS FOR THE REACTIONS $Ne^{20}(d,n)Na^{21}$ g.s. AND $Ne^{20}(d,n)Na^{21}$ (0.34 Mev). E. Farrelly Pessoa, R. L. Dangle, N. Ueta, and O. Sala (Universidade de Sao Paulo, Brazil). Nucl. Phys., 68: 337-51(June 1965).

Absolute cross sections for the reactions $^{20}Ne(d,n)^{21}Na$ g.s. and $^{20}Ne(d,n)^{21}Na$ (0.34 Mev) were measured in the range of incident particle energies from 1.3 to 2.3 Mev. A phenomenological analysis was applied to the total cross section for the $^{20}Ne(d,n)^{21}Na$ (0.34 Mev) reaction to separate the direct interaction contribution from the resonant state formation. The direct interaction contribution turns out to be very small indicating that the predominant reaction mechanism is a resonant type process. (auth)

23717 MEASUREMENTS OF M1 AND E2 TRANSITION PROBABILITIES IN Te^{125}, I^{127}, Xe^{129}, Cs^{133}, La^{139} AND Pr^{141}. J. S. Geiger, R. L. Graham, I. Bergstroem, and F. Brown (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys., 68: 352-68(June 1965).

The mean lives of the first excited states of ^{129}Xe, ^{127}I, ^{133}Cs, and ^{139}La were measured electronically using a time-to-amplitude converter. The percentage E2 admixture in the dominantly M1 radiations de-exciting these states were determined from measurements of the L subshell conversion line intensity ratios for the transitions. The percentage E2 admixture in the 145.43-kev γ transition in ^{141}Pr, the 165.84-kev transition in ^{139}La and the 35.48-kev transition in ^{125}Te were determined in the same way. Summaries were prepared of the presently available information on the M1 and E2 transition rate for the L forbidden M1 transitions of the classes represented by the above transitions ($d_{\frac{3}{2}} \rightarrow s_{\frac{1}{2}}$ and $g_{\frac{7}{2}} \rightarrow d_{\frac{5}{2}}$; $Z \approx 50$). (auth)

23718 ELASTIC AND INELASTIC SCATTERING OF 14.2-Mev NEUTRONS FROM ^{31}P. G. C. Bonazzola and E. Chiavassa (Universita, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nucl. Phys., 68: 369-77(June 1965).

The angular distribution of the elastic scattering of 14.2 Mev neutrons and of the inelastic scattering from the two first excited states in ^{31}P was measured by means of a time-of-flight spectrometer from 30 to 160°. The differential cross sections for elastic scattering and for (n,n') reactions with $Q = -1.26$ Mev and $Q = -2.23$ Mev are given. A comparison between the sum of these two inelastic differential cross sections and the differential cross section for the scattering to the first excited level in ^{32}S is made. (auth)

23719 PROTON TOTAL REACTION CROSS SECTIONS OF CARBON FROM 16 to 28 Mev. Motoji Q. Makino (Univ. of Southern California, Los Angeles), Charles N. Waddell, and Robert M. Eisberg. Nucl. Phys., 68: 378-86(June 1965).

Optical model analysis of the elastic scattering of 18- to 31-Mev protons from carbon has shown that fairly wide variations in the optical model parameters are necessary to reproduce the data. A later analysis of these data in which it was assumed that the scattering amplitude is described by the sum of optical model and Breit-Wigner terms has indicated possible resonances at 19.8, 20.01, and 24.9 Mev (c.m.). The later analysis predicts an inflection point in the proton total reaction cross section at about 21 Mev (lab). The reaction cross sections were measured in the energy range 16 to 28 Mev using the anti-coincidence beam attenuation technique, and the energy variation was achieved with beryllium absorbers and subsequent magnetic analysis. The measured reaction cross section agrees well with the cross section predicted by the later analysis except that there is a weak maximum instead of an inflection point at about 21 Mev (lab). (auth)

23720 ENERGY AND ANGULAR DISTRIBUTIONS OF THE ALPHA PARTICLES FROM 14.1 Mev NEUTRON REACTIONS IN Al^{27} AND Ni^{58}. U. Seebeck and M. Bormann (Universitat, Hamburg). Nucl. Phys., 68: 387-400(June 1965).

A chamber with one CsI(Tl)-scintillation counter was used for the investigation of fast neutron reactions in which charged particles are emitted. Different types of radiation are distinguished by applying the pulse-shape discrimination method. Angular distributions can be measured by successively setting up the targets at different places around the crystal the position of which relative to the neutron source is fixed. The results obtained for the energy and angular distributions of the alpha particles from 14.1-Mev neutron reactions in ^{27}Al and ^{58}Ni are presented. A statistical theory analysis leads to the conclusion that the alpha particles predominantly are evaporated in compound nucleus reactions. Reasonable values for the level density parameter a, the nuclear temperature T and the spin cut-off parameter σ are derived from the data. The alpha particles from ^{27}Al can be attributed entirely to the reaction $^{27}Al(n,\alpha)^{24}Na$ for which a cross section of 119 ± 10 mb is measured. The total alpha particle yield from ^{58}Ni is the sum of the contributions from the reactions $^{58}Ni(n,\alpha)^{55}Fe$, $^{58}Ni(n,\alpha n')^{54}Fe$, and $^{58}Ni(n,n'\alpha)^{54}Fe$. The portion of alpha particles from the latter reaction is separated by means of the statistical theory, and a cross section of 30 ± 6 mb is determined for this process. For the sum of the other two reactions a cross section of 125 ± 16 mb is obtained. Arguments are given for the statement that at least ninety per cent of this cross section may be attributed to the reaction $^{58}Ni(n,\alpha)^{55}Fe$. As far as possible the results are compared with corresponding ones of others. (auth)

23721 DIRECTIONAL CORRELATION OF GAMMA RAYS IN Rh^{105}. J. F. Neeson and R. G. Arns (State Univ. of New York, Buffalo). Nucl. Phys., 68: 401-12(June 1965).

Gamma-gamma coincidence measurements on the decay of 4.4 h ^{105}Ru to ^{105}Rh form the basis for the decay scheme proposed. Directional correlation measurements were made on the 315–470, 485–470, and the 317–148 kev cascades. The respective correlation functions are: $W = 1 - (0.012 \pm 0.010)P_2(\cos\theta)$, $W = 1 + (0.079 \pm 0.019)P_2(\cos\theta) + (0.031 \pm 0.022)P_4(\cos\theta)$, and $W = 1 + (0.161 \pm 0.020)P_2(\cos\theta) - (0.036 \pm 0.023)P_4(\cos\theta)$. Spin assignments consistent with these measurements were made to the levels involved. (auth)

23722 POLARIZATION OF NEUTRONS SCATTERED BY CARBON. C. A. Kelsey, S. Kobayashi, and A. S. Mahajan (Univ. of Wisconsin, Madison). Nucl. Phys., 68: 413-16(June 1965). (COO-7-0352)

The polarization of neutrons scattered from carbon was measured at a laboratory scattering angle of 50° for neutron energies between 4.4 and 8.5 Mev. Angular distributions of polarization were obtained at neutron energies of 4.4 and 7.1 Mev. The results show that the polarization reaches a maximum value close to unity at 4.4 and 7.3 Mev. (auth)

23723 THE $E_p = 2.66$ Mev RESONANCE IN $O^{16}(p,p)O^{16}$. V. Gomes, R. A. Douglas, T. Polga, and O. Sala (Universidade de Sao Paulo, Brazil). Nucl. Phys., 68: 417-25 (June 1965).

The absolute differential cross section was measured over the $E_p = 2.66$ Mev resonance [$E_x(^{17}F) = 3.10$ Mev] in $^{16}O(p,p)^{16}O$ at the following angles in the center-of-mass system: 54.5, 70.5, 90.9, 107.0, 125.5, 140.5, and 151.3°. Also angular distributions (15 angles from $\theta_{c.m.} = 30.5$ to 155.6°) were measured at the following energies: 1.473, 1.931, 2.481, 2.652, 2.660, 2.668, and 2.978 Mev. A partial wave analysis of the results were performed. The first analysis used only cross section data as the input to the computer program. The results fail to predict the observed off resonance polarizations. A second analysis using both cross section and polarization data for the input gives a satisfactory fit to all experimental data. The parameters which give the best fit to the data are $\Gamma = 20 \pm 1$ kev (lab), $E_r = 2.663 \pm 0.007$ Mev, and $J^\pi = \frac{1}{2}^-$. (auth)

23724 THE LOW LEVELS OF O^{19}. J. P. Allen (Yale Univ., New Haven), A. J. Howard, D. A. Bromley, and J. W. Olness. Nucl. Phys., 68: 426-44(June 1965).

Gamma radiation studies on the $^{18}O(d,p\gamma)^{19}O$ reaction have established that the 0.096-Mev state and ground state of ^{19}O have angular momentum assignments of $\frac{3}{2}$ and $\frac{5}{2}$, respectively. The 1.47-Mev state is shown to de-excite with a relative intensity of 96.5 ± 1.6% to the 0.096-Mev state and of 3.5 ± 1.6% to the ground state. The predictions of both j-j and intermediate coupling shell models are in excellent accord with these results for an effective neutron charge

of 0.5e, which is also characteristic of ^{17}O. This suggests that the two additional neutrons in ^{19}O do not appreciably enhance the core polarization. No evidence for a recently reported state of ^{19}O at 0.348 Mev was found in studies of gamma de-excitation radiation; it is suggested that this proposed state is spurious and reflects target contamination in the earlier measurement. (auth)

23725 $Co^{59}(n,p)Fe^{59}$ CROSS SECTION AT 14.8 Mev. H. K. Vonach and J. K. Munro, Jr. (Argonne National Lab., Ill.). Nucl. Phys., 68: 445-8(June 1965).

A cross section value of 53 ± 12 mb for the $^{59}Co(n,p)^{59}Fe$ reaction with 14.8-Mev neutrons was obtained from the experimental determination of the cross section ratio $\sigma[^{59}Co(n,p)^{59}Fe]/\sigma[^{59}Co(n,2n)^{58}Co] = 0.071 \pm 0.008$ and the cross section values for the latter reaction reported previously by others. (auth)

23726 CIRCULAR POLARIZATION OF GAMMA-RAYS FOLLOWING THE CAPTURE OF POLARIZED NEUTRONS ON S, V, Co, Cu AND Zr. J. Kopecky, J. Kajfosz, and B. Chalupa (Inst. of Nuclear Research, Prague). Nucl. Phys., 68: 449-62(June 1965).

Results obtained in the measurements of the degree of circular polarization of gamma quanta for some of the transitions from the capture state to the ground or the lowest excited states in ^{33}S, ^{52}V, ^{60}Co, ^{64}Cu, and ^{93}Zr. The most probable values of parameters of some of the participating levels were established on the basis of these results. (auth)

23727 (d,n) THRESHOLDS AND DIRECT PROTON CAPTURE. Jerry B. Marion (Univ. of Maryland, College Park). Nucl. Phys., 68: 463-8(June 1965).

An examination is made of the correlation between the occurrence of intense neutron thresholds in (d,n) reactions and the observation of direct radiative capture to the corresponding levels in (p,γ) reactions on the same target nuclei. It is concluded that all experimental evidence favors a one-to-one correspondence between these effects, indicating large proton reduced widths for all levels observed as intense (d,n) thresholds. It is argued that direct radiative capture should be observable in the $^{10}B(p,\gamma)^{11}C$ reaction and to a lesser extent in certain other reactions. (auth)

23728 BREAKDOWN OF THE PHASE RULE FOR PROTON INELASTIC SCATTERING. K. A. Amos (Univ. of California, Davis), I. E. McCarthy, and K. R. Greider. Nucl. Phys., 68: 469-75(June 1965).

The phase rule of Blair, which has been shown to work very well for the inelastic scattering of composite particles from single-phonon states of nuclei, does not work so well for the inelastic scattering of protons from the same states. It is shown by means of a simple model and by a distorted wave calculation that this is due to the less simple properties of proton optical model wave functions, rather than to any unknown interaction effects. (auth)

23729 A HARTREE-FOCK CALCULATION OF EXCITED STATES OF O^{16}. W. H. Bassichis and G. Ripka (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France and Weizmann Inst. of Science, Rehovoth, Israel). Phys. Letters, 15: 320-2(Apr. 15, 1965).

A Hartree-Fock calculation of the excited states of ^{16}O in which positive parity intrinsic states are built from 2 particle-2 hole and 4 particle-4 hole states is attempted. (C.E.S.)

23730 NILSSON MODEL FOR P^{31}. G. R. Bishop (Univ. of Glasgow), A. Bottino, and R. M. Lombard. Phys. Letters, 15: 323-5(Apr. 15, 1965).

The results of calculations of the level spectrum of ^{31}P made with the Nilsson model are presented. The spin-$\frac{1}{2}$ level at 3.13 Mev was identified with the Nilsson orbit No. 11, and the energy spacing between orbits 9 and 11 was fixed at about 3 Mev. (C.E.S.)

23731 A FIXED-TARGET HOLE ⇌ PARTICLE TRANSFORM FOR SINGLE-NUCLEON TRANSFER STRENGTHS. J. B. French (Univ. of Rochester, N. Y.). Phys. Letters, 15: 327-8(Apr. 15, 1965).

An essential model independent transform relation between the partial sums (for fixed final-state and transferred-particle angular momenta) of the single-nucleon pickup and stripping strengths for the same target is presented. (C.E.S.)

23732 PROTON POLARIZATION IN SMALL ANGLE p-He^4 SCATTERING AT 38.7 Mev. E. Boschitz, M. Chabre, H. E. Conzett, E. Shield, and R. J. Slobodrian (Univ. of California, Berkeley). Phys. Letters, 15: 325-6(Apr. 15, 1965). (UCRL-11964)

Polarized protons were produced as recoils from a hydrogen target bombarded by a beam of alpha particles at ~80 Mev. The proton polarization was taken to be $P_1 = +0.83 \pm 0.03$, with the probable error arising principally from counting statistics. The protons were scattered from the He gas target at a mean energy of 38.7 ± 0.6 Mev. The intensity distribution and location of the beam at the gas target center, as well as its alignment with respect to the precision scattering table were determined by beam profile measurements. The polarization was determined as a function of the center of mass scattering angle. (C.E.S.)

23733 THE LOWEST NEGATIVE PARITY STATE IN F^{17} AND O^{17}. B. Margolis and N. De Takacsy (McGill Univ., Montreal). Phys. Letters, 15: 329-31(Apr. 15, 1965).

Previous experiments on the decay $^{17}N \xrightarrow{\beta^-} {}^{17}O$ and on the mirror decay $^{17}Ne \xrightarrow{\beta^+} {}^{17}F \rightarrow {}^{16}O + p$ are discussed. The curious feature of the observed decay schemes is the very weak beta decay to the 3.10-Mev $\frac{1}{2}^-$ level of ^{17}F and the 3.06-Mev $\frac{1}{2}^-$ level of ^{17}O. It is pointed out that this weak beta decay is consistent with a two-particle-one hole configuration. It is assumed that the low lying negative parity states of the A = 17 isobars ^{17}N, ^{17}O, ^{17}F, and ^{17}Ne can be described in terms of a $1p_{\frac{1}{2}}$ or $1p_{\frac{3}{2}}$ hole coupled to a core consisting of the A = 18 isobars ^{18}O, ^{18}F, and ^{18}Ne. (C.E.S.)

23734 THE $d + He^3 \rightarrow (p^+p) + H^3$ REACTION AND FINAL STATE p-p INTERACTION. E. M. Henley (Univ. of Washington, Seattle), F. C. Richards, and D. U. L. Yu. Phys. Letters, 15: 331-4(Apr. 15, 1965).

The region of phase space where the final state interaction of the protons is of importance is investigated in the reaction $d + {}^3He \rightarrow (p^+p) + {}^3H$. The two dominant reaction modes are the pickup (or stripping) of a neutron by the deuteron (from the ^3He) and a charge exchange interaction which converts the deuteron into a (p + p) system. Both of these modes have their counterparts in the elastic scattering. The reaction was studied in the Born approximation and by comparing it to the elastic scattering. The magnitude of the differential cross section obtained from the elastic differential cross section is consistent with experiment but only with inclusion of final state p-p scattering effects. (C.E.S.)

23735 ON THE SUPERCONDUCTIVITY THEORY OF THE NUCLEAR PAIRING INTERACTION. Y. Nogami (McMaster Univ., Hamilton, Ont.). Phys. Letters, 15: 335-7(Apr. 15, 1965).

In the Bardeen–Cooper–Schrieffer theory applied to the nuclear pairing interaction there is, in general, a critical interaction strength below which the superconductivity solution does not exist. That is, for sufficiently weak interactions the approximation gives no configuration mixing at all. A method that has a wider range of applicability is discussed. In this method the superconductivity solution is found to exist for any interaction strength. The gap parameter does not show any sudden change as a function of the coupling constant G and approaches zero smoothly as G tends to zero. As an illustration, the case of two levels with the same pair degeneracy Ω and with Ω pairs of nucleons is discussed. (C.E.S.)

23736 LOCAL ENERGY APPROXIMATION FOR FINITE-RANGE IN STRIPPING REACTIONS. J. K. Dickens, R. M. Drisko, F. G. Perey, and G. R. Satchler (Oak Ridge National Lab., Tenn.). Phys. Letters, 15: 337-9(Apr. 15, 1965). (ORNL-P-1102)

Approximate treatments of the finite-range effects

in distorted-wave calculations of stripping and pickup reactions are discussed. Preliminary results which compare the local energy approximation to exact calculations for some typical examples are presented. The $^{40}Ca(d,p)$ and $^{16}O(n,d)$ reactions are treated. (C.E.S.)

23737 EFFECT OF SPIN CORRELATION UPON THE NEUTRON CROSS SECTION OF METHANE. Paul Michael (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 138: A692-4(May 3, 1965). (BNL-8665)

It is shown that the effect of spin-space correlations upon the neutron-scattering cross section of methane can be included in previously developed techniques in a simple manner. Calculations show that the effect of spin correlations are negligible except at very low temperature. (auth)

23738 MODELS FOR THE MOTION OF A MOLECULE IN A LIQUID AND THEIR APPLICATION TO SLOW-NEUTRON SCATTERING. Alan G. Gibbs and Joel H. Ferziger (Stanford Univ., Calif.). Phys. Rev., 138: A701-8(May 3, 1965).

A kinetic model for the calculation of Van Hove's $G_s(r,t)$ in a fluid is presented in which molecules move by Langevin diffusion between random binary collisions. Thus, the effects on the diffusive motions of molecules of both strong and weak interactions are considered in a manner similar to that of Rice and Allnatt. An expression is given for $S_s(\kappa,\omega)$, the double Fourier transform of $G_s(r,t)$, which is the quantity of interest in the incoherent scattering of slow neutrons. It is found that the Gaussian approximation to $S_s(\kappa,\omega)$ is independent of the ratio of the binary collision rate to the Langevin friction coefficient, but that the non-Gaussian portion is very sensitive to this ratio. It is also shown that the Gaussian approximation to this model is equivalent to making the Fokker-Planck approximation to a Boltzmann-like collision integral in a certain kinetic equation. The limited data available show the model to be superior to either the hard collision or Langevin model alone, but the agreement is still not satisfactory. Further modifications that can improve agreement are suggested. (auth)

23739 MÖSSBAUER EFFECT AT HIGH PRESSURE FOR Fe^{57} IN TITANIUM, VANADIUM, AND COPPER. C. K. Edge, R. Ingalls, P. Debrunner, H. G. Drickamer, and H. Frauenfelder (Univ. of Illinois, Urbana). Phys. Rev., 138: A729-31(May 3, 1965). (COO-1198-232)

The effect of pressure to 250 kbar on the isomer shift of ^{57}Fe in dilute solution in titanium, vanadium, and copper was measured. These results and previously published data on ^{57}Fe in iron indicate that for the b-c-c metals of the first transition-metal series, the 4s-electron density scales approximately with bulk density. For more closely packed phases the s-electron density changes less rapidly than the bulk density. (auth)

23740 MEAN-SQUARE NUCLEAR DISPLACEMENT OF Fe^{57} IN Zn FROM THE MÖSSBAUER EFFECT. R. M. Housley (Univ. of Washington, Seattle) and R. H. Nussbaum. Phys. Rev., 138: A753-4(May 3, 1965).

Iron-57 in Zn shows a quadrupole splitting of 0.53 ± 0.03 mm/sec and a chemical shift of −0.53 ± 0.02 mm/sec relative to an Fe metal absorber at room temperature. The measurements of the Mössbauer fraction f indicate a ratio of mean-square displacements $\langle x^2\rangle_{||}/\langle x^2\rangle_{\perp} \geq 2$ at room temperature relative to the crystal c axis. This is in qualitative agreement with lattice-dynamical calculations. (auth)

23741 HIGHER ORDER CORRECTIONS TO THE CRANKING MODEL. Samuel M. Harris (Purdue Univ., Lafayette, Ind.). Phys. Rev., 138: B509-13(May 10, 1965). (COO-1420-108)

The energy levels of the ground-state bands of several deformed nuclei are calculated using a scheme whereby higher order terms in ω (nuclear angular velocity) are retained in the cranking model. Two-parameter and three-parameter fits are obtained to the absolute energies. (auth)

23742 DECAY OF Ir^{196}. W. N. Bishop (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 138: B514-19 (May 10, 1965). (BNL-8674)

Iridium-196 (120 min) was produced by the (d,α) reaction on ^{198}Pt. The iridium was chemically separated from the target material. Gamma-ray, beta-ray, gamma-gamma, beta-gamma, and gamma-ray sum coincidence spectra were measured. Iridium-196 decays by a single beta group with an end-point energy of 0.95 Mev. The beta decay is followed by a cascade of six gamma rays of 100, 355, 389, 442, 518, and 646 kev. This decay is compatible with the known level scheme of ^{196}Pt. (auth)

23743 REINVESTIGATION OF ^{132}Cs DECAY. Noah R. Johnson (Oak Ridge National Lab., Tenn.), H. W. Boyd, E. Eichler, and J. H. Hamilton. Phys. Rev., 138: B520-5 (May 10, 1965). (ORNL-P-937)

There has been some disagreement in the literature as to the properties of the low-lying states in ^{132}Xe, and in particular as to the energy of the second excited state of this nucleus. The decay of ^{132}Cs has been reinvestigated by use of p-i-n lithium-drifted germanium detectors having high resolution, and it is found that the first and second excited states in ^{132}Xe are depopulated by transitions with respective energies of 668.8 ± 1.0 and 630.7 ± 1.5 kev. In addition, gamma rays were also observed with the germanium detectors at energies of 464 ± 3, 507 ± 3, 511 ± 3, 773 ± 5, 1037 ± 3, 1140 ± 1.2, 1233 ± 3, 1300.0 ± 1.5, 1320.0 ± 1.5, and 1985 ± 5 kev. Gamma-gamma (NaI) coincidence measurements, made with a 100- by 200-channel multiparameter analyzer, revealed several new features of the decay. The excited levels observed in ^{132}Xe are at 668.8 ± 1.0, 1299.5 ± 2.0, 1442 ± 3, 1808.3 ± 2.2, and 1988.8 ± 2.5 kev. Levels are 464 ± 3 and 1037 ± 3 kev in ^{132}Ba are also populated. (auth)

23744 NUCLEAR ENERGY STATES OF I^{129}. D. D. Bornemeier, V. R. Potnis, L. D. Ellsworth, and C. E. Mandeville (Kansas State Univ., Manhattan). Phys. Rev., 138: B525-30(May 10, 1965).

The quantum radiations emitted in the decay of ^{129m}Te-^{129}Te were investigated with application of a Ge(Li) detector, scintillation counters, coincidence techniques, and multichannel analysis. In addition to the well-known 27-kev gamma ray, twenty-three others were detected at energies of 205, 250, 273, 277, 340, 448, 455, 482, 523, 548, 550, 630, 660, 698, 725, 770, 797, 810, 835, 945, 1085, 1112, and 1222 kev. Thus, six pairs of gamma rays are present which exhibit within each pair an energy difference of 27 kev. Excited states in ^{129}I are established at 27, 277, 482, 550, 725, 797, and 1112 kev by this energy difference. Additional excited states are found at 837, 1065, 1222, and 1385 kev by coincidence experiments. (auth)

23745 NUCLEAR STRUCTURE AND PARITY IMPURITIES. S. Wahlborn (Royal Inst. of Tech., Stockholm). Phys. Rev., 138: B530-9(May 10, 1965).

Nuclear-structure calculations, relevant to the evaluation of irregular gamma-ray transition amplitudes (parity-forbidden multipoles), were performed. General expressions were derived for the case of one-particle states in odd-A nuclei with spherical or spheroidal shape. In particular, the pseudoscalar operator $\sigma\cdot p$ is discussed. The case of regular M1 plus irregular E1 transition is considered as an application. Results are derived for the transitions of 482 kev in ^{181}Ta, 343 kev in ^{175}Lu, and 14 kev in ^{57}Fe. For ^{181}Ta, it is possible to calculate the magnitude and the sign of the nuclear matrix-element ratio R. Comparing the theoretical result for the circular polarization, $P \propto FR$, with recent measurement, gives the following limits for the amplitude factor $F: 9 \lesssim 10^7 \times F \lesssim 110$. This result agrees in sign and order of magnitude with estimates derived from the current-current theory of weak interactions. (auth)

23746 MASSES OF THE STABLE CHLORINE ISOTOPES. J. W. Dewdney and K. T. Bainbridge (Harvard Univ., Cambridge, Mass.). Phys. Rev., 138: B540-4 (May 10, 1965).

The mass differences between the components of several doublets which involve the stable chlorine isotopes were measured in a large mass spectrometer operating at a resolving power, at the base of the peaks, of 10^5 or better. These measurements lead to the following values of atomic

mass, expressed as mass excesses on the $^{12}C = 12$ u scale: $^{37}Cl = -34099.73 \pm 0.95$ μu; $^{35}Cl = -31148.62 \pm 0.68$ μu; $^{37}Cl-^{35}Cl = -2951.11 \pm 0.59$ μu. (auth)

23747 ENERGY LEVELS OF Pb^{210} FROM SHELL THEORY. Martin G. Redlich (Univ. of California, Berkeley). Phys. Rev., 138: B544-53(May 10, 1965). (UCRL-11735)

The calculations for ^{210}Pb were based upon the double-closed-shell-core model with harmonic-oscillator wave functions. All two-neutron configurations of the $2g_{9/2}$, $1i_{13/2}$, $1j_{15/2}$, $3d_{5/2}$, $4s_{1/2}$, $2g_{7/2}$, $3d_{3/2}$ main shell are included. A singlet-even Gaussian effective interaction with parameters determined by low-energy proton-proton scattering and zero triplet-odd effective interaction give, within 50 kev, the binding energy of the two outer nucleons determined from experimental data and the energies of four excited states which have been experimentally identified. An empirical relation between matrix elements for slightly different parameters is described. It indicates that the interaction and the harmonic-oscillator parameter ν used here also give the general agreement with experiment which had been obtained for ^{206}Pb with similar parameters. Calculations with a Yukawa singlet-even interaction and with additional attractive and repulsive central and central + tensor triplet-odd effective interactions were made ^{210}Pb; they all lead to somewhat worse agreement. None of these interactions is, however, definitely excluded by the present data. Level schemes, tables of level energies and of some wave functions, and detailed formulas for the calculation of γ-ray transition probabilities are given. A model for the 2.15-Mev $1/2^-$ state of ^{209}Pb is also discussed. (auth)

23748 DECAY OF Au^{195}. J. R. Harris, G. M. Rothberg, and N. Benczer-Koller (State Univ., New Brunswick, N. J.). Phys. Rev., 138: B554-60(May 10, 1965).

The decay of ^{195}Au was re-examined by gamma-ray spectroscopy techniques in order to obtain a more reliable value of the internal conversion coefficient α of the 99-kev ground-state transition. The ^{195}Au decays by electron capture to the ground state of ^{195}Pt and to the first three excited states at 99, 130, and 210 kev. The relative-decay branching ratios to these states are (13 ± 10), (47 ± 6), (40 ± 6), and <0.04%, respectively. The decay energy $W_0 = (222 \pm 5)$ kev was determined from the observed L/K capture ratios. Four gamma rays are present in the decay with energy and relative intensity: 31 kev (12%), 99 kev (100%), 130 kev (7.7%), and 210 kev (0.25%). The K internal conversion coefficient α_K of the 99-kev ground-state transition is $\alpha_K = 5.9 \pm 0.6$ which, together with the experimental result $\alpha_K/(\alpha_L + \alpha_M) = 4.7$ of de-Shalit et al., yields a value for the total internal-conversion coefficient $\alpha = 7.2 \pm 0.7$. Finally, the half life of the 99-kev state was determined from the measurement of the linewidth in the recoilless-absorption spectrum of the 99-kev radiation: $\tau_{1/2} = (1.7 \pm 0.2) \times 10^{-10}$ sec. (auth)

23749 $B^{11}(d,p)B^{12}$ ANGULAR DISTRIBUTIONS AT $E_d = 5.5$ Mev FOR THE B^{12} 2.62- AND 2.72-Mev LEVELS. A. Gallmann (Institut de Recherches Nucleaires, Strasbourg), F. Hibou, P. Fintz, P. E. Hodgson, and E. K. Warburton. Phys. Rev., 138: B560-8(May 10, 1965).

The angular distributions of the $^{11}B(d,p)^{12}B$ reaction leading to the 0.95-, 1.67-, 2.62-, 2.72-Mev levels of ^{12}B were measured at an incident deuteron energy of 5.5 Mev. The angular distribution of the elastically scattered deuterons from ^{11}B was also measured. The results were analyzed both by Butler theory and by zero-range distorted-wave Born-approximation calculations. The orbital angular momentum transferred in the reaction was determined to be $l_n = 1$, 0, 0, and (1) for these states of ^{12}B. Some $^{11}B(d,p\gamma)^{12}B$ measurements were made. The results for the decay of the 1.67-, 2.62-, and 2.72-Mev states were consistent with previous work. The 3.39-Mev level of ^{12}B was found to have a partial width for gamma decay which is less than 10% of the total width. The level structure of ^{12}B is compared with the spectrum of ^{12}C above 15-Mev excitation. Recent $^{11}B(d,p)^{12}B$ angular-distribution measurements of Mingay are used to analyze Doppler-shift measurements of Warburton and Chase for the ^{12}B 1.67- and 2.62-Mev levels. The result is limits of less than 10^{-13} sec on the mean lifetimes of both states. (auth)

23750 LEVELS OF Cr^{53} AND Cr^{55} FROM (d,p) REACTIONS. L. D. Singletary and M. R. Miller (Lockheed Research Labs., Palo Alto, Calif.). Phys. Rev., 138: B569-71(May 10, 1965).

Chromium isotopes ^{52}Cr, ^{53}Cr, and ^{54}Cr were bombarded with 2.8-Mev deuterons and the resultant protons analyzed with a 16-in. broad-range spectrograph. Comparison of results between 30- and 90-deg exposures corroborated most of the energy levels found. Energy levels are reported in ^{55}Cr at 0.246, 0.522, 0.583, 0.881, 1.206, 1.474, 2.020, 2.268, and 2.779 Mev and in ^{53}Cr at 0.568, 1.007, 1.297, 2.322, and 2.670 Mev. These are compared with recent experimental results. (auth)

23751 EXCITATION FUNCTION AND INTEGRAL RECOIL PROPERTIES OF THE $Cu^{65}(p,p\pi^+)Ni^{65}$ REACTION. L. P. Remsberg (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 138: B572-82(May 10, 1965). (BNL-8635)

The excitation function for the $^{65}Cu(p,p\pi^+)^{65}Ni$ reaction was measured from 0.49 to 28 Bev. With other data, this provides a complete excitation function for this reaction from threshold to 28 Bev. The excitation function is dominated by a broad peak at ~1.3 Bev which is due to the $(3/2,3/2)$ π^+-p resonance. Thick-target, integral recoil experiments were performed at 2.8 and 28 Bev. The experimental excitation function and the results of the recoil experiments were compared with the results of an improved version of the calculation of Ericson, Selleri, and Van de Walle. Agreement between the experimental data and the calculations is obtained only when the one-pion-exchange (OPE) theory is used to describe the inelastic p-p interaction occurring in the nucleus. These results indicate that the treatment of the $(p,p\pi^+)$ reaction by Ericson et al. is basically correct and that OPE theory remains valid at energies up to 28 Bev, at least at the low momentum transfers selected by the $(p,p\pi^+)$ reaction. These data also suggest that the exchange of one unit of isotopic spin at very high energies is not greatly suppressed at low momentum transfers. (auth)

23752 INTERMEDIATE-STATE THEORY OF SINGLE-PARTICLE RESONANCES. L. Garside and W. M. MacDonald (Univ. of Maryland, College Park). Phys. Rev., 138: B582-5(May 10, 1965).

The $d_{5/2}$ state in oxygen is observed as a very sharp scattering resonance in $^{16}O(n,n)^{16}O$. The state is a virtual state, therefore, and its inclusion among the single-particle discrete states employed in the shell-model description of states of ^{16}O requires some justification. A unified reaction theory is used as the basis of a description in which the resonance is described as arising from the virtual transitions into a true bound state. The continuum states of this description are nonresonant because the continuum $d_{5/2}$ resonance is replaced by a bound $d_{5/2}$ state which plays the role of a new doorway state. This description leads to the conventional shell-model description of the particle-hole resonances of ^{16}O and simplifies the description of the interaction between virtual and bound states. (auth)

23753 INELASTIC DEUTERON SCATTERING AND (d,p) REACTIONS FROM ISOTOPES OF Ti. II. $Ti^{47}(d,p)Ti^{48}$. P. D. Barnes (Yale Univ., New Haven), C. K. Bockelman, Ole Hansen, and A. Sperduto. Phys. Rev., 138: B597-607(May 10, 1965). (MIT-2098-118)

The (d,p) reaction from a target of isotopically separated ^{47}Ti was studied at 6-Mev bombarding energy. Proton spectra were recorded simultaneously at 24 scattering angles with an over-all energy resolution of 15 kev by means of a broad-range, multiple-gap, heavy-particle spectrograph. Fifty-five proton groups, corresponding to levels in ^{48}Ti, were observed. To forty of these (d,p) groups, transition strengths and values of the orbital angular momenta of the transferred neutrons were assigned by means of a distorted-wave analysis of the differential cross sections. A sum-rule analysis shows that

virtually all of the $1f_{\frac{7}{2}}$, $2p_{\frac{3}{2}}$, and $2p_{\frac{1}{2}}$ single-particle strengths and 25% of the $1f_{\frac{5}{2}}$ strength were observed. A level scheme for ^{49}Ti is proposed, and the available spectroscopic information on the low-lying levels is discussed in terms of current nuclear models. (auth)

23754 EXPERIMENTAL STUDY OF THE 2I + 1 RULE USING THE (d,α) REACTION ON F^{19}, Na^{23}, Al^{27}, AND P^{31}. S. W. Cosper and O. E. Johnson (Purdue Univ., Lafayette, Ind.). Phys. Rev., 138: B610-14(May 10, 1965). (COO-1420-109)

The angular distributions corresponding to the (d,α) production cross sections ($E_d \approx 9.3$ Mev) for the ground states and some of the low-lying states of ^{17}C, ^{21}Ne, ^{25}Mg, and ^{29}Si were measured using silicon surface-barrier detectors. The discussion of the 2I + 1 rule within the context of these experimental observations is based on the premise that both the direct interaction (DI) and compound nucleus (CN) mechanisms contribute incoherently to the angular distributions, and the approximate validity of an ad hoc method used for the decomposition of these differential cross sections into DI and CN components. The integrated experimental differential cross sections, $\sigma_T(10-170°)$ and $\sigma_B(90-170°)$, and the integrated CN component, $\sigma_{CN}(10-170°)$, are analyzed in terms of the 2I + 1 rule. The σ_{CN} values are found to be more nearly proportional to 2I + 1 than either the σ_T or σ_B values. This result is interpreted as indicating that the 2I + 1 dependence of the (d,α) cross sections is a characteristic associated with the CN mechanism rather than the DI mechanism. Furthermore, it is concluded that spin assignments based solely on the assumption of a 2I + 1 dependence of either the σ_T or σ_B values derived from (d,α) reactions would not as a rule be very reliable. (auth)

23755 COULOMB DISPLACEMENT ENERGIES DERIVED FROM THE (p,n) ISOBARIC REACTION. J. D. Anderson, C. Wong, and J. W. McClure (Univ. of California, Livermore). Phys. Rev., 138: B615-18(May 10, 1965). (UCRL-12178)

The agreement of Coulomb displacement energies derived from the nonmirror (p,n) isobaric reaction with those obtained from mirror and nonmirror (T = 1) nuclei beta decay has been previously demonstrated. Using the Livermore 90-in. cyclotron time-of-flight facility, additional Coulomb displacement energies in the mass region $70 \leq A \leq 108$ were measured. These measurements indicate possible shell effects which were previously not observed because of the paucity of data. With the availability of 20.5-Mev protons, Coulomb displacement energy measurements were extended to the mass region $A \leq 165$. Even for nuclei as heavy as ^{165}Ho, where the Coulomb displacement energy is 16.6 Mev, the width of the isobaric neutron group was not measurable (≤150 kev). The variation of the uniform radius parameter with atomic weight (A) inferred from these data is compared with that obtained from high-energy electron scattering experiments and is found to be in substantial agreement. A semiempirical formula for calculating Coulomb displacement energies is presented. (auth)

23756 PRODUCTION OF GALLIUM ISOTOPES IN COPPER BY HIGH-ENERGY PROTONS. John Warren (Univ. of Chicago and Univ. of California, Davis) and Anthony Turkevich. Phys. Rev., 138: B627-36(May 10, 1965). (TID-21527)

The production of ^{66}Ga, ^{67}Ga, and ^{68}Ga in copper foils by high-energy protons was determined by radiochemical techniques. Cross section measurements were made for a series of copper foils ranging in thickness from 8 to 555 mg/cm^2 at each of the four proton energies 123, 254, 351, and 440 Mev. The thickness variations of the cross sections for all three isotopes were found to be consistent with the concept that these isotopes are formed by the capture in copper nuclei of alpha particles produced in primary interactions. Spectra of alpha particles with energies greater than 14 Mev which satisfactorily reproduced the experimental thickness variations were determined at each proton energy. These spectra were found to consist of a large number of evaporation alpha particles with a small forward-directed alpha-particle component. No evidence was found for the primary reaction ^{65}Cu(p,π$^-$)^{66}Ga; the contribution of such a reaction to the total ^{66}Ga production cross section is less than one-third of a microbarn in natural copper at a proton energy of 440 Mev. (auth)

23757 Λ-Λ POTENTIAL FROM ANALYSIS OF $_{\Lambda\Lambda}$Be^{10}. Y. C. Tang (Univ. of Minnesota, Minneapolis) and R. C. Herndon. Phys. Rev., 138: B637-43(May 10, 1965). (UCRL-12208)

The strength of the Λ-Λ interaction in the $^1S_0$ state is determined by analyzing the double hypernucleus $_{\Lambda\Lambda}$Be^{10} treated as a four-body system of 2α + 2Λ. The α-α potential chosen fits the $^1S_0$ phase shifts up to a c.m. energy of about 12 Mev. The α-Λ potential is determined from the binding energy of $_\Lambda$He^5, taking into proper account the size of the alpha particle and the range of the Λ-nucleon interaction. With these potentials, the binding energy of $_\Lambda$Be^9 is also given correctly. For the Λ-Λ part, a potential is used which has a hard core of radius 0.4 F and an attractive well of exponential shape. The intrinsic range is chosen as 1.5 F, corresponding to the mechanism of 2-pion exchange. Using a 12-parameter variational function, the Λ-Λ $^1S_0$ potential which yields the observed separation energy of the two Λ particles in $_{\Lambda\Lambda}$Be^{10} is found to have a well-depth parameter of $0.732^{+0.033}_{-0.031}$, which is about 10% smaller than the value obtained by treating $_{\Lambda\Lambda}$Be^{10} as a three-body system of Be^8 + 2Λ. The scattering length and effective range are equal to −(1.04) and 2.91 F, respectively. Also, it was found that the ^{8}Be core in $_{\Lambda\Lambda}$Be^{10} is quite compressed, with the α-α separation about 12% smaller than the corresponding separation in $_\Lambda$Be^9. (auth)

23758 ΛΛ HYPERNUCLEUS $_{\Lambda\Lambda}$Be^{10} AND THE Λ-Λ INTERACTION. A. R. Bodmer (Argonne National Lab., Ill.) and Shamsher Ali. Phys. Rev., 138: B644-52 (May 10, 1965).

The ΛΛ hypernucleus $_{\Lambda\Lambda}$Be^{10} was analyzed by use of a four-body α-α-Λ-Λ model which allows for distortion of the core by the Λ particles. In particular, the dependence of the internal energy of the core on the rms separation of the α particles is required. This was obtained from three-body α-α-Λ calculations for $_\Lambda$Be^9. Several types of α-α potentials, whose s-wave phase shifts had been previously obtained, were considered. Calculations for $_{\Lambda\Lambda}$Be^{10} were made for a singlet Λ-Λ Yukawa potential (I) of intrinsic range b = 1.48 F, appropriate to the exchange of two pions, and for a hard-core Yukawa potential (II) with a hard-core radius r_c = 0.42 F and b = 2.66 F, appropriate to a range corresponding to two pion masses for the attractive Yukawa part. Results are also given for a hard-core meson-theory potential (III) which has r_c = 0.42 F and b = 1.48 F. Calculations for III were made for $_{\Lambda\Lambda}$He^6, and the results were adapted to $_{\Lambda\Lambda}$Be^{10}. For α-α potentials which give s-wave phase shifts consistent with experiment, it is found that (almost independently of the details of the Λ-Λ potential) the effects of core distortion account for rather more than a third of the experimental additional binding energy of 4.5 ± 0.5 Mev which is obtained after the Λ separation energy of $_\Lambda$Be^9 has been allowed for. Slightly more than half the contribution due to core distortion comes from the core energy of $_\Lambda$Be^9. The remainder is due to the further distortion of the core by the second Λ, which causes approximately a 10% decrease in the rms α-α separation relative to the value for $_\Lambda$Be^9. The effects of core distortion weaken the resulting Λ-Λ potential quite appreciably. For b = 1.48 F, one obtains the scattering length $a_{\Lambda\Lambda} \approx -1 \pm 0.3$ F and the effective range $r_{0\Lambda\Lambda} \approx 3.3 \pm 0.6$ F, approximately independent of the shape of the Λ-Λ potential. For II, one gets $a_{\Lambda\Lambda} = -2.3^{+0.5}_{-0.7}$ F and $r_{\Lambda\Lambda} = 4.9^{+1.5}_{-0.7}$ F. The well-depth parameters are 0.45 ± 0.08, 0.675 ± 0.065, and 0.77 ± 0.04 for I, II, and III, respectively. These values are about 35%, 20%, and 12%, respectively, less than the values obtained for a rigid core with a three-body ^{8}Be-Λ-Λ model. The Σ-Λ-π coupling constant, obtained with III, is close to the value obtained from the singlet Λ-N interaction for the same hard-core radius. (auth)

23759 POLARIZATION AND RELAXATION PROCESSES IN He^3 GASES. Rodger L. Gamblin and Thomas R. Carver (Princeton Univ., N. J.). Phys. Rev., 138: A946-60(May 17, 1965).

Polarization of ^3He when used as a buffer gas for optically pumped rubidium vapor was investigated experimentally and theoretically. Experiment shows that the coupling between a rubidium and ^3He atom is scalar in form (i.e., $I \cdot S$) and is about three orders of magnitude greater than would be expected from the direct magnetic interaction of the dipoles associated with each atom. A theoretical explanation of this effect, which depends upon the overlap of the Rb valence electron with the electrons of the ^3He atom is presented and is in agreement with experiment. Experiments concerning the optical pumping of metastable ^3He atoms in order to produce ground-state polarization are described. Polarizations of 60% in 1-torr (1 STP mm) samples at room temperature and 56% in 3-torr samples at 77°K were achieved. The process of metastable pumping works only at these lower pressures. Mercury liquid is shown experimentally, however, to present a poor surface for ^3He relaxation. This result opens the possibility of achieving high polarization at high pressure using metastable pumping and gas compression. Various wall coatings of ^3He samples are found to have only small effects upon relaxation rates. A 2.1-amagat (1 STP atm) sample in Pyrex but of high purity is found to have a relaxation time of 2×10^4 sec. This value sets present limits upon the experimental $^3He-^3He$ relaxation cross section. A new effect which involves relaxation processes of the ^3He polarization in a magnetic field with a gradient is investigated both experimentally and theoretically. The results of both theory and experiment are in close agreement with each other. An effect involving enhanced polarization of either sign of spin temperature of a high-pressure sample of ^3He in which a gas discharge is struck, and which is in a 10-kG field, is described experimentally. (auth)

23760 THEORY OF PROTON-HYDROGEN COLLISIONS. Ian M. Cheshire (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 138: A992-8(May 17, 1965).

The theory of excitation and charge exchange in proton-hydrogen collisions is discussed within the framework of the impact-parameter method. Consideration is given to the importance of proper boundary conditions. The time-dependent equations linking the amplitudes of the target with those of the rearranged system are written in matrix form. By eliminating the rearrangement amplitudes from these equations, a second-order matrix equation is derived which may be used as a basis for successive approximations which are automatically second order. The theory is generalized with the aid of a two-center expansion of the electronic wave function. The method is illustrated by computing first- and second-order distortion approximations for the reactions $H^+ + H(1s) \rightarrow H^+ + H(2s)$ and $H^+ + H(1s) \rightarrow H(1s) + H^+$, and the results are compared with previous calculations. (auth)

23761 HEAVY-PROJECTILE INELASTIC SCATTERING ABOVE THE COULOMB BARRIER. W. H. Bassichis and A. Dar (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Letters, 14: 648-52(Apr. 19, 1965).

Simple closed-form expressions for the differential cross section and half-width for nuclear and Coulomb excitations are obtained, which permits quick identification of the nature of the excitation process for angular distributions. It is shown that the Born approximation can be used to describe either process if modified to take absorption into account according to the WKB method. The theoretical curves obtained from the equations are compared to the angular distributions for the inelastic scattering $^{12}C + ^{208}Pb \rightarrow (^{12}C + ^{208}Pb)^*$, the breakup reactions $^{197}Au(^6Li,\alpha+d)^{197}Au$ at 60.6 Mev and $^{197}Au(^6Li,\alpha+d)^{197}Au$ at 33 Mev. It is concluded that the dominant process is nuclear in origin for the cases considered. (L.B.S.)

23762 OBSERVATION OF $T = \frac{3}{2}$ LEVELS IN Li^7-Be^7 AND THE UNCHARACTERIZED NUCLEI He^7, B^7, AND He^8. Claude Detraz, Joseph Cerny, and Richard H. Pehl (Univ. of California, Berkeley). Phys. Rev. Letters, 14: 708-10 (Apr. 26, 1965). (UCRL-16014)

The location and properties of the hitherto unestablished $T = \frac{3}{2}$ levels in the $T_z = \pm\frac{1}{2}$ nuclei ^7Li and ^7Be are important nuclear structure information; in addition, the question of particle stability of the controversial nuclei ^7He, ^7B, and ^8He should be answerable by extrapolation from these $T = \frac{3}{2}$ states. To investigate these mass-7 nuclei, the reactions $^9Be(p,t)^7Be$ and $^9Be(p,^3He)^7Li$ were induced by 43.7-Mev protons. The energy spectra and angular distributions were measured. The determination of the lowest $T = \frac{3}{2}$ level energies and widths in ^7Li and ^7Be implies that ^7He is unbound by about 360 kev with a very short half life (some 10^{-21} sec), that ^7B is even more unbound, but that ^8He is bound, decaying by β^- emission with a maximum energy of the order of 10.1 ± 0.4 Mev. (C.E.S.)

23763 MÖSSBAUER HYPERFINE SPECTRA OF Ta^{181} IN Ta AND IN W METALS. W. A. Steyert, R. D. Taylor, and E. K. Storms (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Letters, 14: 739-41(May 3, 1965). (LA-DC-7061)

The possibility of using the 6.2-kev gamma ray of ^{181}Ta for Mössbauer effect studies to examine the character of such a deformed nucleus and the nature of chemical bonding in Ta compounds is considered. Mössbauer hyperfine spectra of ^{181}Ta in tantalum and tungsten metals were presented and discussed. (C.E.S.)

23764 ABSORPTION TIME OF NEGATIVE K^- MESONS IN LIQUID HYDROGEN. R. Knop, R. A. Burnstein, and G. A. Snow (Univ. of Maryland, College Park). Phys. Rev. Letters, 14: 767-9(May 3, 1965).

A measurement of the absorption time of mesons (K^-) in liquid hydrogen can be used as an indirect test of the validity of the prediction that stopping mesons (K^-) are absorbed predominantly from s states of high principal quantum number. Using this model of "Stark-effect" mixing, Bethe and Leon have predicted that the meson (K^-) cascade time (from initial atomic formation to nuclear s-wave absorption) is $T \sim 2.4 \times 10^{-12}$ sec. On the other hand if there were no "Stark-effect" mixing their calculations of the Auger and radiative transition rates indicate that the meson (K^-) cascade time would be $T \sim 30 \times 10^{-12}$ sec. A measurement of this cascade time is reported. A cascade time of $T \lesssim 4 \times 10^{-12}$ sec was found in good agreement with the "Stark-effect" prediction. (C.E.S.)

23765 NUCLEAR FORCES. Josef Kvasnica. Pokroky Mat., Fys. Astron., 9: 18-27(1964). (In Czech)

The meson theory, which explains qualitatively the known properties of nuclear forces, i.e. the short range, spin dependence, exchange character, and saturation property is reviewed. The possibility is discussed of an interaction law which would take into account all experimental observations on nuclear forces and also the effects of strange and resonance particles produced in nucleon-nucleon interactions. (M.J.T.)

23766 ^{206}Hg AS A BRANCHING PART OF THE URANIUM–RADIUM DECAY CHAIN. Gerhard K. Wolf, Franz Lux, and Hans-Joachim Born (Technische Hochschule, Munich). Radiochim. Acta, 3: 206-15(Dec. 1964). (In German)

^{206}Hg, expected as the product of α-branching of ^{210}Pb, was separated in measurable quantity from 100 mC ^{210}Pb. The two step separation is fast. First, the bulk of ^{210}Bi and ^{210}Po is separated by adsorption on a HgO column; after addition of Hg-carrier, ^{210}Pb and the residual ^{210}Bi, ^{210}Po, and ^{206}Tl are separated from ^{206}Hg by multistage precipitation (5 minutes). The half life was found to be 8.1 ± 0.4 min from γ and β measurements. The γ spectrum showed a line at 310 ± 10 kev. The maximum β energy was determined from the decay cycle: 0.98 or 1.29 Mev, respectively. The α-branching fraction of ^{210}Pb was found to be $(2.7 \pm 0.6) \times 10^{-6}$. The possible energy level schemes of ^{206}Tl are discussed in connection with the experimental results. (auth)

23767 EXCITED LEVELS OF Ni^{62}. Kojiro Sato (Chiba Inst. of Tech., Japan). Rept. Chiba Inst. of Technol., No. 5, 54-8(Oct. 1964). (In Japanese)

The excited levels of ^{62}Ni were investigated from the decay of the 9.9-min ^{62}Cu. Sources of ^{62}Cu and ^{62}Zn in equilibrium were prepared by means of the (p,2n) reaction on a natural copper target. The internal conversion electron spectrum and the positron spectrum in the decay of ^{62}Cu were measured with a sector-type double-focusing beta spectrometer. Conversion electron lines corresponding to 0.84, 0.88, and 2.05-Mev transitions were observed. Three beta groups were found in the analysis of the positron spectrum; 2.92 ± 0.01 Mev (91.3%, log ft = 5.1), 1.75 ± 0.01 Mev (1.8%, log ft = 6.2), and 0.87 ± 0.01 Mev (1.5%, log ft = 4.8). (NSA of Japan)

23768 THE MÖSSBAUER EFFECT IN DIATOMIC LATTICE. Isao Mannari (Shizuoka Univ., Shizuoka City, Japan). Repts. Liberal Arts Sci. Faculty Shiquoka Univ., Nat., Sci., 3: 199-208(Jan. 1964).

With some simplifying assumptions as to the lattice vibration, the absorption of γ quanta by nuclei in a diatomic lattice in which one of the nuclei is the radiator is studied. It is shown that Visscher's way of analysis of the Mössbauer effect can be extended directly to observe the frequency spectrum of phonons in the diatomic crystal. Some criteria are given for favorable situations for observing the Mössbauer effect. With the use of a sum rule, the intensities of the recoilless absorption and of the absorption with phonon exchange are discussed. (auth)

23769 CALCULUS OF THE ABSOLUTE LOG ft VALUES FOR THE FIRST-FORBIDDEN β TRANSITIONS OF THE ODD-A NUCLEI IN THE $150 \leq A \leq 190$ REGION. D. Bogdan (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 543-7(1964).

The absolute log $(f_c t)_R$ values were calculated by means of formula $(f_c t)_R = \pi^3 \ln 2/(\eta)^2 R$. The expression $\eta = C_A \int B_{ij}$ was used as standard matrix element. In some of the cases the theoretical $(f_c t)_R$ values are approximately equal to the experimental $(ft)_{exp}$ values which are usually given in the literature. In most cases in which the theoretical $(f_c t)_R$ values are sensibly larger than the usual ones, the Kotani corrective term log $[f_c(0)/f_0(0)]$ was also calculated and it followed that the latter was sufficiently large to permit the conclusion that in these cases too the superfluid model correction improved the theoretical values. (auth)

23770 EFFECT OF NONLOCAL POTENTIAL IN FAVORED ALPHA TRANSITIONS. A. Sandulescu and H. Stefan (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 591-8(1964).

The effect of the Chaudhury nonlocal interaction potential between an alpha particle and a nucleus on the relative intensities of preferred alpha transitions is studied. The odd-A nuclei ^{233}U, ^{239}Pu, ^{241}Am, ^{243}Am, and ^{243}Cm are studied, using a relation between the reduced widths of preferred alpha transitions for nuclei of odd and of even A. Results do not differ essentially from those obtained using the Igo local potential for the alpha particle-nucleus interaction. (tr-auth)

23771 THE COLLECTIVE EXCITATION OF NUCLEAR MATTER UNDER CERTAIN CONDITIONS. S. Fujii. Soryushiron Kenkyu, 27: 110-23(1963). (In Japanese)

The collective excitations for N > z nuclear matter are considered, and the hamiltonian operator for the neutron-proton interaction, which is taken as a δ-type force, is given. The excited state energy of the nucleon state is obtained using the Sawada approximation, and the relation is given between the energy and momentum, q. It is shown that the collective state is the state of isotopic spin when q = 0. The state corresponding to $\Delta L = 0$, $\Delta S = 1$ is also considered, and an expression is obtained for the width. Calculations are made for ^{208}Pb for this state and a width of $\Gamma \sim 0.9$ Mev was obtained. (L.B.S.)

23772 THE APPROXIMATE INTERACTION IN ENERGY REGION NEAR THE THRESHOLD OF NUCLEAR REACTION AND THE BOUND STATE OF H^3. K. Shimoake. Soryushiron Kenkyu, 27: 178-95(1963). (In Japanese)

The phenomenological form of the two-body interaction (not containing the tensor force) is suggested for application to two-body scattering of nucleons in the nucleus. The virtual level (J = 1 np scattering) is extended to the coupling of the virtual level for the T = 1, J = 0 state of two nucleons under the assumption of isotopic spin independence; and the interaction which is symmetrical for J, T is obtained. The interaction is used in the energy region below the threshold, based on the analysis of the S matrix; and the two-nucleon interaction is therefore obtained. The binding energy of ^3H, calculated from the interaction, was found to be 11.0 Mev. A comparison with the calculated value of scattering length of a pn quartet state proves that the interaction is in agreement with the potential theory which does not have a tensor force. It is shown by the results that there are also virtual levels in the Spp and Snn states within the limit of isotopic spin independence. (L.B.S.)

23773 THE SPECTRA OF β-RAY. M. Morita and R. Morita. Soryushiron Kenkyu, 27: 223-57(1963). (In Japanese)

The corrections of β spectra are discussed and compared with the Langer effect. A general expression and a form for the unique first forbidden transition for the Langer correction factor are given. The corrections due to the following effects are discussed: ionization of orbital electrons, finite de Broglie wavelength, finite nucleus, second order, forbidden matrix, conserved vector current, pseudoscalar interaction, and radiative correction. Other corrections are also considered. (L.B.S.)

23774 THE DESCRIPTION OF ROTATIONAL MOTION IN A SYSTEM OF DEFORMED POTENTIAL — A THREE DIMENSIONAL CASE. Y. Shono. Soryushiron Kenkyu, 27: 277-94(1963). (In Japanese)

The possibility of describing the motion of two-dimensional rotation in terms of a potential is shown by the wave function of rotation similar to that of the cranking model obtained by applying the hamiltonian operator, the two-dimensional hamiltonian operator plus the two-dimensional Q-Q interaction. The result is extended to the case of three-dimensions. (L.B.S.)

23775 NON-STATIC EFFECT IN NUCLEAR FORCE. M. Mastud. Soryushiron Kenkyu, 27: 309-21(1963). (In Japanese)

It is pointed out that the experimental data of low energy scattering in the region I of nuclear force may be described in terms of one-pion exchange potential. It is however shown by the data of high energy that there exists in the region II of nuclear force a strong L-S potential which cannot be obtained from the π-meson theory and it is also shown by the phenomenological analysis that a non-static potential exists as well. The models of one-boson exchange potential (OBEP) and one-boson exchange contribution (OBEC) were used for describing the strong L-S potential in region II. (L.B.S.)

23776 THEORY OF ALLOWED BETA-RAY SPECTRA. R. Marita. Soryushiron Kenkyu, 27: 395-402(1963). (In Japanese)

The effects of the ionization of orbital electrons caused by β decay and the correction of second order on the allowed spectrum are discussed. The change in the total decay rate due to the effect of imperfect overlapping, and the anti-symmetry exchange effect of the bound and free electrons in the final states, are considered. The contributions of the second order effect are calculated for ^{114}In $(1^+ \rightarrow 0^+)$, and are found to be in agreement with Langer's result for Fermi theory and the theory of conserved vector current. (L.B.S.)

23777 ANOMALY IN THE BOUND MUON DECAY RATE. M. Tanifuji. Soryushiron Kenkyu, 27: 428-34 (1963). (In Japanese)

Two methods for determining the total disappearance rate of a bound μ meson are presented. It is pointed out that the anomaly at Fe observed by Chilton cannot be de-

scribed by μ capture. It is further pointed out that the μ-decay may be affected by the deformations and vibrations of nuclei. (L.B.S.)

23778 NON-STATIC POTENTIAL OF TRIPLET EVEN STATE. R. Tamagaki, N. Wata, and W. Watari. Soryushiron Kenkyu, 27: 546-60(1963). (In Japanese)

The upper limit of the triplet even LS force is determined by taking the quadratic spin-orbital (QSO) force as a free parameter, and the lower limit is restricted by the magnetic moment of the deuteron. The following principal conclusions are obtained: if $^3V^+_{LS}$ is monotonous, the QSO force has an intensity with a Hamada-Johnston potential; if $^3V^+_{LS}$ is of a monotonous shape, negative in region II and positive in region III, then the QSO force is only $\frac{1}{2}$ of the previous case. It is noted that other causes must be considered in describing the complexity of the LS force, in addition to the exchange contribution of bosons, and it is also necessary to evaluate correctly the non-static potentials other than the LS force. (L.B.S.)

23779 ON THE CALCULATION OF ENERGY OF THE GROUND STATE OF THE THREE-NUCLEON SYSTEM. [PART] II. Yu. P. Shcherbin. Vestn. Leningr. Univ., No. 22, Ser. Fiz. i Khim., No. 4, 56-60(1964). (In Russian)

The binding energy of the three nucleon system is calculated for central nucleon-nucleon interactions. The wave function of the three nucleon state is represented as the product of eigenfunctions which are the solutions of the boundary problem in an ordinary differential equation. The comparison of the results obtained with the variational results shows that method proposed is more effective for the case of singular potentials. (auth)

23780 SEARCH FOR RADIATION PROCESSES OF SECOND ORDER IN THE DECAY OF ^{109m}Ag. K. Knauf and H. Sommer (Universitat, Heidelberg). Z. Physik, 183: 10-24(1965). (In German)

The decay of an excited state by the emission of two γ quanta, two conversion electrons, or one γ quantum and one conversion electron is expected as a second-order radiation process. The decay of ^{109m}Ag was examined for such events, using a special arrangement of two NaI scintillation counters in coincidence. The energies of coincident quanta were displayed on the two axes of an "x-y" oscilloscope respectively. For the ratio of γ-γ transitions to one-quantum transitions an upper limit of $\leqq 1.9 \times 10^{-5}$ was obtained. Furthermore, the γ spectrum in coincidence with K x rays was studied. From these measurements electron-electron and γ-electron transition rates were calculated for the case of K-shell conversion. (auth)

23781 LIFETIME MEASUREMENTS ON EXCITED NUCLEAR LEVELS WITH THE METHOD OF DELAYED COINCIDENCES. A. Huebner (Justus Liebig-Universitat, Giessen, Ger.). Z. Physik, 183: 25-35(1965). (In German)

The lifetimes of excited states in ^{72}As, ^{80}Br, ^{164}Ho, ^{95}Mo, ^{99}Mo, ^{188}Re, ^{152}Sm, and ^{180}W were measured using the method of delayed coincidences and a time-to-pulse-height converter. (D.C.W.)

23782 ON THE NUCLEAR REACTIONS OF ^{28}Si WITH 14-Mev NEUTRONS. D. Hilscher, H. H. A. Morgenstern, and J. A. Scheer (Hahn-Meitner-Institut fur Kernforschung, Berlin). Z. Physik, 183: 77-82(1965). (In German)

The charged particle spectra from the reactions (n,α), (n,p), and (n,d) on ^{28}Si were measured by irradiating solid-state detectors with 14-Mev neutrons. The background due to escape effects was reduced by pulse shape discrimination. From coincidence measurements between two detectors facing each other, information on angular distributions and the spectrum of protons only was obtained. (auth)

23783 INVESTIGATION OF THE IRIDIUM-191m DECAY. Dieter Lange (Universitat, Gottingen, Ger.). Z. Physik, 183: 90-9(1965). (In German)

The γ-radiation of the nuclear isomer ^{191m}Ir ($T_{\frac{1}{2}}$ = 4.5 sec) was investigated using a scintillation fast-slow coincidence spectrometer. The γ rays of the 42 kev-transition were measured for the first time. The conversion coefficient α of this transition was found to be α = 13500 in acceptable agreement with the value taken from the tables of Rose under the assumption of an E3 transition. Thus this assignment proposed earlier by other authors was confirmed. The K-conversion coefficient of the 129-kev transition was remeasured yielding, $\alpha_K = 2.32 \pm 0.06$. (auth)

23784 INVESTIGATION OF THE GAMMA RADIATION FROM CAPTURE OF THERMAL NEUTRONS IN ^{149}Sm WITH THE SUM-COINCIDENCE METHOD. Otto Zehender and Rudolf Fleischmann (Universitat, Erlangen-Nuremburg). Z. Physik, 183: 217-22(1965). (In German)

Two-step cascades of neutron capture γ-rays of ^{149}Sm (n,γ)^{150}Sm were studied by means of the sum-coincidence method. 11 two-step transitions from the capturing state to the 0.33 and 0.77 Mev states were found. Most of them agree with the decay scheme of Groshev et al., some are new. The relative intensities of the cascades were determined. No two-step transition from the capturing state to the ground state could be observed. The main result is shown. (auth)

23785 SIMULTANEOUS MEASUREMENT OF HYPERFINE STRUCTURE, STARK EFFECT, AND ZEEMAN EFFECT OF ^{23}Na^{19}F WITH A MOLECULAR BEAM RESONANCE APPARATUS. G. Graeff and G. Werth (Universitat, Bonn). Z. Physik, 183: 223-33(1965). (In German)

An electric molecular beam resonance spectrometer was used to measure simultaneously the Zeeman- and Stark-effect splitting of the hyperfine structure of ^{23}Na^{19}F. Electric four pole lenses served as focusing and refocusing fields of the spectrometer. A homogenous magnetic field (Zeeman field) was superimposed to the electric field (Stark field) in the transition region of the apparatus. The observed ($\Delta m_J = \pm 1$)-transitions were induced electrically. Completely resolved spectra of NaF in the J = 1 rotational state were measured in several vibrational states. The obtained quantities are: the electric dipolmoment μ_{el} of the molecule for v = 0, 1 and 2, the rotational magnetic dipolmoment μ_J for v = 0, 1, the difference of the magnetic shielding ($\sigma_\perp - \sigma_{||}$) by the electrons of both nuclei as well as the difference of the molecular susceptibility ($\xi_\perp - \xi_{||}$), the spin rotational constants c_F and c_{Na}, the scalar and the tensor part of the molecular spin-spin interaction, the quadrupole interaction eqQ for v = 0, 1 and 2. The numerical values are given. (auth)

23786 DETERMINATION OF THE HIGH FIELD BOUNDARIES OF THE DYNAMIC NUCLEAR POLARIZATION FROM THE DISPERSION OF NUCLEAR RELAXATION. K. H. Hausser (Max-Planck Institut fur Medizinische Forschung, Heidelberg). Z. Physik, 183: 265-73 (1965). (In German)

The dynamic nuclear polarization arising from dipolar interactions between unpaired electrons and protons in liquids decreases with increasing magnetic field H_0. Since the polarization involves the same electron-proton flip-flop processes which are responsible for nuclear magnetic relaxation, the maximum possible enhancement factor V_{max} of the protons in paramagnetic solutions was determined as a function of the applied magnetic field from the dispersion of nuclear magnetic relaxation. The measurements of the frequency dependence of nuclear magnetic relaxation in the field range of 33 to 38000 G show that V_{max} drops to one half of its low field value in fields of 2000 to 6000 G depending on the solvent and on the temperature. An appreciable enhancement of the order of 50 or more seems to be possible in magnetic fields up to 30 or 40 kG. (auth)

23787 THE HYPERFINE STRUCTURE IN THE $4f^7$6s6p LEVELS OF Eu I AND THE ELECTRIC NUCLEAR QUADRUPOLE MOMENT OF ^{151}Eu AND ^{153}Eu. W. Muelier, A. Steudel, and H. Walther (Technische Hochschule, Hanover). Z. Physik, 183: 303-320(1965). (In German)

The hyperfine structure of the states $z^{10}P_{11/2}$, $z^{10}P_{9/2}$, $z^{10}P_{7/2}$, $z^8P_{9/2}$, $y^8P_{9/2}$, $y^8P_{7/2}$, $y^8P_{5/2}$, $z^6P_{7/2}$, $z^6P_{5/2}$ of the $4f^7$6s6p configuration of EuI was investigated with a photoelectric recording Fabry Perot spectrometer using enriched isotopes of ^{151}Eu and ^{153}Eu, which were excited in liquid air cooled hollow cathodes. From the measurements the values obtained for

the nuclear quadrupole moments were $Q(^{151}Eu) = (1.16 \pm 0.08) \cdot 10^{-24}$ cm² and $Q(^{153}Eu) = (2.92 \pm 0.20) \cdot 10^{-24}$ cm². (auth)

23788 NOTE ON THE ABSOLUTE VALUES OF α-WIDTHS IN NUCLEI. Joerg Eichler and Hans-Joerg Mang (California Inst. of Tech., Pasadena and Univ. of California, Berkeley). Z. Physik, 183: 321-2(1965).

The discrepancies in previous calculations of α-transition rates of nuclei are pointed out, and it is shown that values for the absolute transition rates are too small by a factor of 8. (L.B.S.)

23789 COULOMB BREAK-UP AND POSSIBLE EVIDENCE FOR CLUSTER EFFECTS IN SOME LIGHT NUCLEI. J. M. Hansteen and H. W. Wittern (Florida State Univ., Tallahassee). Z. Physik, 183: 447-52(1965).

The possibility of obtaining information about cluster structures in light nuclei from Coulomb break-up experiments is discussed. A few favorable cases are pointed out. A preliminary estimate of the break-up cross section of ^{7}Li into alpha particles and tritons and of ^{7}Be into alpha particles and ^{3}He in the field of a heavy target nucleus is given. The need for more experiments as well as more refined calculations is stressed. (auth)

23790 MEASUREMENT OF THE g_R FACTOR OF THE 2+ ROTATION STATE OF ^{160}Dy ACCORDING TO THE SPIN ROTATION METHOD AND DETERMINATION OF THE MULTIPOLE MIXTURES OF SEVERAL γ TRANSITIONS IN DECAY OF ^{160}Tb. C. Guenther, G. Strube, U. Wehmann, W. Engels, H. Blumberg, H. Luig, R. M. Lieder, E. Bodenstedt, and H. J. Koerner (Universitat, Bonn and Universitat, Hamburg). Z. Physik, 183: 472-98(1965). (In German)

A differential measurement of the spin rotation of ^{160}Dy in the 2+ rotational state was performed by using liquid sources of $TbCl_3$ solved in 3M HCl and applying an external magnetic field of 33,500 gauss. No change of the Larmor precession frequency could be detected within the first 10×10^{-9} sec. It is concluded that the ground state of the electronic shell of Dy^{3+} is reached in 6×10^{-10} sec after the beta decay of ^{160}Tb. The value $g_R = +0.364 \pm 0.011$ was derived using $\langle r^{-3}\rangle_{eff} = 8.92$ a.u. for the 4*f*-shell of Dy^{3+}. A comparison with the result of Cohen who studied the Mössbauer effect in Fe_2Dy shows that the value of $\langle r^{-3}\rangle_{eff}$ must be 10% larger in this compound. A measurement of the effective magnetic field at the position of the nucleus in a source of terbium metal was performed for different temperatures. It revealed a temperature dependence which is very similar to the paramagnetic susceptibility $\chi(T)$. A strong attenuation of gamma-gamma angular correlations in the 2+ rotational state was observed. For liquid sources of $TbCl_3$ in HCl the following attenuation parameters were measured: $\lambda_2 = 0.122 \pm 0.013 \times 10^9$ sec^{-1} and $\lambda_4 = 0.235 \pm 0.024 \times 10^9$ sec^{-1}. The ratio λ_4/λ_2 deviates from the value which is expected for the attenuation by internal fields of the 4 *f*-electronic shell. Possible reasons are discussed. The multipole mixtures of gamma transitions in the decay of ^{160}Tb were derived, and the half life of the 2+ rotational state was redetermined to be $1.99 \pm 0.04 \times 10^{-9}$ sec. (auth)

23791 SEARCH FOR A SUPER-ALLOWED β^- DECAY OF H^4. J. Jaenecke (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrums, Karlsruhe, Ger.). Z. Physik, 183: 499-503(1965).

If a beta-decaying ^{4}H exists, a super-allowed transition to the excited analog state of ^{4}He is possible. Such a decay mode was not considered in previous experiments. The reaction ^{6}Li(γ,2p)^{4}H was used to produce ^{4}H. No super-allowed β^--decay of ^{4}H could be observed, and upper limits for the production cross section are given. (auth)

23792 DETERMINATION OF THE (631)K = 1/2, I = 1/2-ZUSTANDES IM U-239. Bernd P. K. Maier (Technische Hochschule, Munich and Danische Atomenergiekommission, Risø, Denmark). Z. Physik, 184: 143-52(1965). (In German)

The γ ray spectrometer at the DR 3-reactor at Risø was used to investigate the low-energy γ lines of ^{239}U which are emitted during neutron capture in ^{238}U. Very closely lying lines were found between 500 and 650 kev. The big intensity of the 133-kev line and the lack of other transitions of appropriate energy and intensity point out that this line corresponds to the hindered E2-transition from the (631) $I = 7/2^+$ level to the (622) $I = 5/2^+$ groundstate. A suggestion was made for the decay possibility of the octupole states at 700 kev found by Fiebiger. (auth)

23793 LOW-ENERGY GAMMA LINES FROM NEUTRON CAPTURE IN ^{175}Lu AND ^{176}Lu. Bernd P. K. Maier (Technische Hochschule, Munich and Danische Atomenergiekommissionen, Risø, Denmark). Z. Physik, 184: 153-74(1965). (In German)

The low-energy gamma rays from neutron capture in ^{175}Lu and ^{176}Lu were investigated by means of the bent-crystal spectrometer at the DR-3-reactor at Risø. From the transitions in ^{177}Lu, three rotational bands were determined. The levels of the (404) $K = 7/2^+$ groundstate rotational band are: 121.62 kev ($I = 9/2$); 268.79 kev ($I = 11/2$); 440.66 kev ($I = 13/2$); 636.22 kev ($I = 15/2$); 854.34 kev ($I = 17/2$). The level-sequence of the (514) $K = 9/2^-$-band is: 150.39 kev ($I = 9/2$); 288.99 kev ($I = 11/2$); 451.49 kev ($I = 13/2$); 637.05 kev ($I = 15/2$); and 844.88 kev ($I = 17/2$). At 457.92 kev is the basis for the (402) $K = 5/2^+$-band, the higher levels of which are 552.05 kev ($I = 7/2$); 671.89 kev ($I = 9/2$); 816.63 kev ($I = 11/2$); 985.23 kev ($I = 13/2$); 1176.73 kev ($I = 15/2$); and probably 1389.5 kev ($I = 17/2$). The energies of the levels apart from the 1389-kev level have an accuracy of 7×10^{-5}. The energy differences between the three bands agree very well with the values expected from the Bohr-Mottelson-formula $E = A \cdot I(I+1) + B \cdot I^2(I+1)^2$. The calculated branching-ratios within the three bands are in fairly good agreement with the experimental values. The g_K-factors were determined for two bands: it was found that for the (514) band $g_K = 1.16 \pm 0.04$ and for the (402) band $g_K = 1.33 \pm 0.07$. (auth)

23794 MEASUREMENT OF THE HIGH-ENERGY CONVERSION ELECTRONS OF ^{150}Sm AFTER NEUTRON CAPTURE. Th. Elze, T. V. Egidy, and E. Bieber (Technische Hochschule, Munich). Z. Physik, 184: 229-32(1965). (In German)

In the energy range from 5 to 8 Mev, internal conversion electrons emitted by ^{150}Sm after neutron capture were measured by means of the beta spectrometer at the research reactor at Garching near Munich. Twenty lines corresponding to eighteen transitions were found. (auth)

23795 THE DECAY OF ^{158m}Tb. W.-D. Schmidt-Ott, F. Smend, and A. Flammersfeld (Universitat, Gottingen, Ger.). Z. Physik, 184: 310-18(1965). (In German)

^{158m}Tb was produced from ^{159}Tb by the (n,2n) reaction and investigated using scintillation spectrometers. The following results were obtained: half life $T_{1/2} = (10.5 \pm 0.2)$ sec; energy of the isomeric transition $E_\gamma = (109.9 \pm 1.5)$ kev; conversion coefficients $\alpha_K = 56 \pm 3$, $\alpha_L + \alpha_M + \cdots = 50 \pm 8$, $\alpha_{total} = 106 \pm 10$; K/L-ratio $K/L = 1.3 \pm 0.3$, yielding the multipole order of the isomeric transition to be M3. Upper limits for direct beta transitions from the isomeric state to the ground states of the neighboring even-even nuclei ^{158}Gd and ^{158}Dy are 10^{-4} and $6 \cdot 10^{-3}$, respectively. (auth)

23796 THE $C^{12}(\alpha,p_0)N^{15}$ REACTION FROM 16 TO 26 Mev α-PARTICLES. I. B. Teplov and L. N. Fateeva (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 385-92(Feb. 1965). (In Russian)

The excitation curves and angular distributions of protons from the $^{12}C(\alpha,p_0)^{15}N$ reaction are studied experimentally in the range of α-particle energies from 16 to 26 Mev. The excitation curves have a resonance structure which apparently is related to the mechanism of compound nucleus formation. The angular distributions strongly depend on the α-particle energies. The differential cross section maxima are observed in the large angle region for almost all energy values. The shape of the angular distributions indicates that direct processes make an appreciable contribution to the reaction mechanism. However the theory of direct reactions cannot explain the observed energy dependence of the angular distributions. (auth)

23797 MEASUREMENT OF THE MAGNETIC MOMENT OF THE PROTON IN NUCLEAR MAGNETONS. B. A.

Mamyrin and A. A. Frantsuzov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 48: 416-28(Feb. 1965). (In Russian)

A new technique for measuring the magnetic moment of the proton in terms of the nuclear magneton with aid of a resonance magnetic mass-spectrometer is suggested. The cyclotron frequency is measured for a single revolution of the ions in the apparatus which is a favorable feature of the method. The magnitude of the magnetic moment of the proton in nuclear magnetons (without any correction for diamagnetic screening of hydrogen nuclei in water) is 2.79279 ± 2. The spread of the results of the measurements is $\pm 3.5 \times 10^{-6}$ of the measured value (mean square error). The total mean square error of the measurements is $\pm 6 \times 10^{-6}$. (auth)

23798 EFFECT OF THE FINITE SIZE OF THE NUCLEUS ON THE INTENSITY OF CHARACTERISTIC X-RAYS. F. A. Babushkin. Zh. Eksperim. i Teor. Fiz., 48: 561-4(Feb. 1965). (In Russian)

An expression is derived for the probability of a relativistic radiative electric multipole transition. Oscillator strengths for the $K \rightarrow L_{II}$ and $K \rightarrow L_{III}$ transitions in heavy elements and the relative intensity of the $K_{\alpha 2}$ line in the characteristic x radiation are calculated. The effect of the finite size of the nucleus on the oscillator strength and relative intensity of the $K \rightarrow L_{II}$ transition is taken into account. (auth)

23799 ANGULAR DISTRIBUTIONS IN PAIR PRODUCTION BY CHARGED PARTICLES. V. D. Mikhailov. Zh. Eksperim. i Teor. Fiz., 48: 695-700(Feb. 1965). (In Russian)

The angular distributions of secondary particles formed during electron-positron pair production by a fast charged particle in the field of the nucleus are calculated. Distributions are presented for the pair particles as well as for the impinging particle after the collision. (auth)

23800 RADIONUKLID-TABELLEN. (Radionuclide Tables). W. Seelmann-Eggebert and G. Pfennig. [Bad Godesberg, Ger.], Bundesministerium fur Wissenschaftliche Forschung, 1964. 79p.

A tabulation is presented of the radioisotopes. The types of decay, half life, radiation energy and frequency, and the daughter nuclides are given. (J.S.R.)

23801 ETUDE DU Be^9 PAR DIFFUSION DES ELECTRONS. ETATS DISCRETS ET CONTINUUM. (Study of ^9Be by Scattering of Electrons. Discrete States and Continuum). Hoan Nguyen Ngoc. Thesis, Paris, Universite de Paris, 1964. 48p.

The discrete and continuum states of ^9Be were studied by scattering of electrons at energies from 70 to 250 Mev. The experimental technique was described, and the theoretical formulas necessary for the analysis of the results were reviewed. The technique for the analysis of the results and the formulas used were discussed in detail. The results showed the excitation of the 1.6-, 2.47-, and 6.4-Mev levels, the first of which had been observed only in scattering of heavy particles. The cross sections of excitation of these levels were given, and their transition characteristics were defined. A detailed study was made of the application of various models to the two higher levels. A systematic study of the excitation of the continuum was undertaken, and a general analysis technique was derived. The general formulas for the corrections necessary for the extraction of the cross sections were established from the experimental measurements. These methods were applied to the experimental results on ^9Be, and three distinct models were used to interpret the nuclear cross sections. (J.S.R.)

23802 INTRODUCTION TO THE ATOMIC NUCLEUS. J. G. Cunninghame. Topics in Inorganic and General Chemistry. Monograph 3. New York, American Elsevier Publishing Co., Inc., 1964. 229p. $9.00.

The basic physics of the atomic nucleus is presented in a manner intelligible to non-nuclear physicists. General properties of the nucleus are described, and types of nuclear forces are discussed and compared with experimental results. Stable and radioactive nuclides are considered. Various nuclear models are reviewed. Nuclear reactions are classified, and energy balance and cross sections are discussed. Observations and theories of fission are surveyed. Properties and models of alpha decay, beta decay, and gamma emission are described. Interactions of heavy charged particles, electrons, gamma rays, and neutrons with matter are discussed. (M.J.T.)

23803 TABELLE ZUR IDENTIFIZIERUNG UNBEKANNTER GAMMASPEKTREN. (Table for the Identification of Unknown Gamma Spectra). A. Rakow. Munich, Verlag Karl Thiemig KG, 1962. 70p.

Data on gamma-emitting isotopes are tabulated, including half lives, gamma energies, and the number of quanta of each energy emitted per 100 decays. (D.C.W.)

23804 INVESTIGATION OF THE $^{27}Al(p,\gamma)^{28}Si$ REACTION. A. Heyligers. Thesis, Utrecht, Univ. of Utrecht, 1964. 124p.

The reaction $^{27}Al(p,\gamma)^{28}Si$ was investigated with protons 500 to 800 kev. The excitation curve exhibits twelve resonances. By measuring single and coincidence gamma-ray spectra, the decay and branching ratios are determined of the resonance levels and of the lower levels. Angular correlation measurements were made for the determination of the spins and parities of the concerning resonance levels. Several methods of analysis were used to compute the magnitude of the requested parameters. (R.C.N.)

23805 HIGH-SPIN LEVELS OF Mg^{24}. J. A. Kuehner and E. Almqvist (Atomic Energy of Canada Ltd., Chalk River, Ont.). 10p. (CONF-758-4)

From American Physical Society Meeting, New York, Jan. 1965.

The results of an investigation of the gamma decay of ^{24}Mg energy levels excited in the $^{12}C(^{16}O,^4He)^{24}Mg$ reaction are presented. Evidence was obtained for high-spin levels of rotational bands in ^{24}Mg. (D.C.W.)

23806 STUDIES ON MULTIPLE COULOMB SCATTERING IN NUCLEAR EMULSION STACK EXPOSED TO FOUR PRIMARY ENERGIES. P. L. Jain and Edward Wong (Univ. of Buffalo). 3p. (CONF-758-3)

From American Physical Society Meeting, New York, Jan. 1965.

The spurious scattering and the scattering constant were investigated as a function of cell size by exposing a stack of Ilford K nuclear emulsion to four proton beams with energies of 5, 8, 12, and 24 Bev/c at different angles, but intersecting at a common point. The results were compared with theoretical predictions. (D.C.W.)

23807 DECAY OF Ge^{69}. Judith K. Temperley, David K. McDaniels, and Donald O. Wells. 13p. (CONF-641210-9)

From American Physical Society Meeting, Berkeley, Calif.

The energy levels of ^{69}Ga were investigated by observing the gamma rays emitted following the beta decay of ^{69}Ge. The half life of ^{69}Ge was found to be 35.5 ± 0.8 hr. It was tentatively concluded that the 872- and 1106-kev levels have assignments of $5/2^-$ and $3/2^-$, respectively, with both the 237- and 872-kev transitions appearing to be thoroughly mixed M1-E2. (D.C.W.)

23808 TOTAL NEUTRON CROSS SECTIONS FROM 90 TO 150 Mev. D. F. Measday and J. N. Palmieri (Harvard Univ., Boston). 10p. (CONF-641210-8)

From American Physical Society Meeting, Berkeley, Calif.

The preliminary results of a measurement of the neutron total cross sections of aluminum, carbon, nitrogen, and oxygen at 90 to 150 Mev are presented and compared with previous data. The cross sections for the first three elements are in good agreement with the published values. (D.C.W.)

23809 DATA ACQUISITION FOR GRADUATE STUDENTS. Louis J. Koester, Jr. (Univ. of Illinois, Urbana). 5p. (CONF-776-4)

From National Electronics Conference, Chicago, Oct. 1964.

The thesis experiments of three Ph.D. candidates are cited to provide illustrations of scientific information gathering. Included are: a study of meson (π^-) production by x rays interacting with neutrons bound in helium-4 nuclei; a study of the photodisintegration of helium-3 using a 22-Mev betatron; and a study of $\gamma' + {}^3He \rightarrow \pi^+ + {}^3H$ using a 300-Mev betatron. Some representative qualitative results are given for each experiment. (R.E.U.)

23810 CIRCULAR POLARIZATION OF EXTERNAL BREMSSTRAHLUNG FROM ^{210}Bi BETA RAYS. Mary E. Cunningham (Univ. of Oregon, Eugene). 20p. (CONF-641210-12)

From American Physical Society Meeting, Berkeley, Calif.

The degree of circular polarization of the external bremsstrahlung produced by the beta rays from ^{210}Bi was measured by the Compton scattering technique. The results are consistent with an electron longitudinal polarization of 0.731. (auth)

23811 PHENOMENOLOGICAL POTENTIALS AND THE D(n,p)2n REACTIONS. PART II. D. R. Koehler (Army Missile Command, Redstone Arsenal, Ala.). 14p. (CONF-641114-2)

From American Physical Society, Southeastern Section, Chattanooga.

The differential cross sections and proton energy spectra for the D(n,p)2n were calculated within the direct-interaction framework using the Yale and Hamada-Johnston N-N potentials. The tensor potentials were incorporated in the description of the final-state two-body "particles." The results were compared with previous calculations for which the Gammel-Thaler phenomenological potentials were used and with experimental results. The Gammel-Thaler and Hamada-Johnston potentials gave better agreement with the experimental results than the Yale potentials. (D.C.W.)

23812 PRESSURE DEPENDENCE OF THE INTERNAL FIELD AT THE Co^{59} NUCLEUS IN A 99.5% Ni–0.5% Co ALLOY. Lawrence H. Bennett (National Bureau of Standards, Washington, D. C.). 8p. (CONF-794-8)

From Magnetism Conference, Minneapolis, Nov. 1964

The room temperature nuclear magnetic resonance absorption of ^{59}Co in an alloy of 0.5% Co in Ni was measured under hydrostatic pressures of up to 7 kbars. The change in the resonance frequency with pressure was $\Delta\nu/\Delta p = 159 \pm 5$ Hz/bar. This was in the same direction (increasing frequency for increasing pressure) as for ^{61}Ni in Ni. The ratio of the resonance frequency at absolute zero to the change in frequency with pressure $\nu : \Delta\nu/\Delta p$ was 750 kbar for ^{59}Co and 1200 kbar for ^{61}Ni in Ni. The internal field at the ^{59}Co nucleus decreased with increasing temperature more slowly than that at the ^{61}Ni nucleus in Ni-rich Ni-Co alloys. This discrepancy in the temperature dependences remained as large, when plotted at constant volume, as it was at constant pressure. (auth)

23813 NUCLEAR MAGNETIC RESONANCE SHIFT OF Xe^{131} IN SOLID AND LIQUID XENON. William W. Warren (Washington Univ., St. Louis). 13p. (CONF-641210-13)

From American Physical Society Meeting, Berkeley, Calif.

The temperature-dependent shift of the nuclear magnetic resonance of ^{131}Xe in solid and liquid xenon was measured from 4.2 to 2.50°K in a magnetic field of 8600 gauss using samples of normal isotopic abundances. In the solid, the local magnetic field was found to increase linearly with density with $(d\Delta H/dp)_{solid} = H_0(18.2 \pm 1.1) \times 10^{-7}$ gauss/amagat, in substantial agreement with the result of Yen and Norberg for ^{129}Xe, and in disagreement with the work of Brinkmann for ^{129}Xe. The shift in the liquid was observed to be proportional to the density with $(d\Delta H/dp)_{liquid} = H_0(5.1 \pm 0.5) \times 10^{-7}$ gauss/amagat. The ^{131}Xe shift at the melting transition was found to be 0.37 ± 0.10 gauss compared to the melting point shift of 0.2 gauss reported for ^{129}Xe in a field of 8920 gauss by Yen and Norberg. (auth)

23814 A COMPARATIVE STUDY OF EXPERIMENTAL LINE WIDTHS IN THE Fe-57m TRANSITION USING A VARIETY OF SOURCE MATRICES. 19p. (CONF-571-38)

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

Mossbauer spectra were obtained using sources made from Cr, Cu, Pd, and Pt foils onto which 4 mC of ^{57}Co were electroplated with subsequent annealing. Absorbers of natural iron with thicknesses of 10 and 20 mg/cm^2 were used, together with absorbers of enriched iron with a thickness of 1.9 mg/cm^2. Line widths, isomer shifts, and percent effects were determined. (D.C.W.)

23815 THE PROBABLE OBSERVATION OF A LEVEL AT $E_X = 1.34$ Mev IN ^{33}S. Jean M. O'Dell and F. W. Prosser, Jr. (Univ. of Kansas, Lawrence). 10p. (CONF-641004-8).

From American Physical Society, Chicago.

An attempt was made to observe the 1.38-Mev, $\frac{1}{2}^+$ energy level of ^{33}S recently predicted by the shell model. Proton spectra from the ^{32}S(d,p)^{33}S reaction were measured, together with the spectra of gamma rays in coincidence with the protons. It was concluded that the existence of a state at 1.34 ± 0.06 Mev in ^{33}S is highly probable and that this state decays predominantly through the level at 0.841 Mev. A decay scheme was constructed incorporating this level. (D.C.W.)

23816 THE INELASTIC SCATTERING OF PROTONS BY Li^6. William D. Harrison (California Inst. of Tech., Pasadena). 8p. (CONF-641210-10)

From American Physical Society Meeting, Berkeley, Calif.

The inelastic scattering of protons to the first and second excited states of ^{6}Li was investigated. The data were analyzed under the assumption that the prominent maxima observed in the two inelastic scattering channels were due to the same resonance state in ^{7}Be. Under this assumption, it was concluded that the state should be $\frac{3}{2}^-$. Evidence was also obtained for another broad $\frac{3}{2}^-$ level at higher excitation with $T = \frac{3}{2}$. (D.C.W.)

23817 NOTE ON THE Li^7 QUADRUPOLE MOMENT. [PART] II. R. D. Present (Univ. of Tennessee, Knoxville). 11p. (CONF-641114-4)

From American Physical Society, Southeastern Section, Chattanooga.

The recently determined electric quadrupole moment Q of the ^{7}Li nucleus disagrees with the predictions of current nuclear models. It is shown that the quadrupole and magnetic moments, together with the Gamow-Teller matrix element for the ^{7}Be $\rightarrow$ ^{7}Li (ground state) K-capture, can be accounted for on the supermultiplet theory if the wave function has a 65% admixture of the ^{2}P [3] states arising from the $1s^4\ 1p^2\ 2p$ (two) and $1s^4\ 1p^2\ 1f$ (one) configurations. Assuming equal configuration admixtures in both levels of the ground doublet term ($^2P_{\frac{1}{2},\frac{3}{2}}$), the M1 and E2 transition strengths for quantum jumps between the ground state ($^2P_{\frac{3}{2}}$) and the first excited state ($^2P_{\frac{1}{2}}$) at 478 kev were calculated and found to agree with measured values of B(M1) and B(E2) within experimental error. The reduced E2 transition strength in emission is given by: $B(E2) \cong Q^2$. Pure LS coupling and exact partition symmetry are assumed. (auth)

23818 EXCHANGE AND OVERLAP EFFECTS IN ELECTRON CAPTURE RATIOS: PHYSICAL BASIS AND EXPERIMENTAL TESTS. John N. Bahcall (California Inst. of Tech., Pasadena). 11p. (CONF-233-2)

From Conference on the Role of Atomic Electrons in Nuclear Transformations, Warsaw, Sept. 1963.

The physical basis for exchange and overlap corrections in electron capture processes is discussed. A number of experimental comparisons and predictions is presented. (auth)

23819 CAPTURE-GAMMA DETERMINATION OF Ca^{41} STRUCTURE AND THE THERMAL NEUTRON CROSS SECTION OF Ca^{42}. 12p. (CONF-641210-3)

From American Physical Society Meeting, Berkeley, Calif.

The energy levels of ^{43}Ca were investigated by measuring the single and coincidence gamma spectra of ^{43}Ca from thermal neutron capture. A decay scheme for ^{43}Ca was proposed. The cross section for thermal neutron capture by ^{42}Ca was also determined. (D.C.W.)

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Refer also to abstract 22485.

23820 (AD-606290) SCATTERING OF ELECTROMAGNETIC WAVES FROM THE DISTURBANCE CAUSED BY A RAPIDLY MOVING BODY IN PLASMAS. Technical Note R-111. Suc Kyuen Suh (Brown Engineering Co., Inc., Huntsville, Ala. Research Labs.). Aug. 1964. Contract DA-01-021-AMC-85(Z). 31p. $2.00(CFSTI).

The scattering of electromagnetic waves by a body moving in a plasma is discussed in detail. General theory covering scattering phenomena is developed, with emphasis on a perturbation method that can be used to obtain reasonably accurate differential cross section under different physical conditions. The general theory is extended to investigate the following two problems: the scattering of electromagnetic waves from the disturbance caused by a rapidly moving body in the ionosphere; and the scattering of electromagnetic waves from the turbulent wake produced by a re-entry vehicle. In the first problem, kinetic equations are used to find the frequency spectrum of the electron density fluctuations in terms of which the differential scattering cross section can be expressed. In the second problem the differential scattering cross section is obtained in terms of the correlation function for turbulence, which can be estimated by using the correlation length. (auth)

23821 (CEA-R-2701) DETERMINATION EXPERIMENTALE DE LA DENSITE SUR LE CANON A INDUCTION PAR L'ELARGISSEMENT STARK DE LA RAIE Dβ. (Experimental Determination of the Density on the Induction Gun Using the Stark Widening of the Dβ Line). Jean Jacquinot and Francois Waelbroeck (Commissariat à l'Énergie Atomique, Fontenary-aux-Roses (France). Centre de Études Nucléaires). Nov. 1964. 33p. (EUR-2154.f). Dep.(mn).

A survey is made of the characteristics of the apparatus and of the assembly used. The alignment and calibration techniques are examined, and the measurement results are given together with a discussion of the possible causes of error in the interpretation of the profiles obtained. A study is made of the modifications in the profile of the Dβ line emitted by a non-homogeneous plasma: these can be quite pronounced, even in the case of a gaussian radial distribution of the plasma density. (auth)

23822 (CEA-R-2743) PRELIMINAIRES MATHEMATIQUES A UNE ETUDE SUR LES ONDES DANS LES PLASMAS. (Mathematical Preliminaries for a Study of Waves in a Plasma). Michel Trocheris (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses (France). Centre de Études Nucleaires). Feb. 1965. 38p. (EUR-2234.f). Dep.(mn).

Proofs are given for mathematical results that are used in a study of the linear and "quasi-linear" approximation for "electrostatic" waves in a uniform plasma. Certain classes of functions of a complex variable, which are analytic in a strip parallel to the real axis, are defined and studied. In particular, properties of convergence of a sequence and of continuity with respect to a parameter are established for functions remaining inside one such class. The results are used to prove an existence theorem for the simplest equation in the quasi-linear theory of plasma waves. A number of elementary lemmas are proved. (auth)

23823 (MATT-258) FINITE-RESISTIVITY INSTABILITIES OF A SHEET PINCH WITH FIRST-ORDER GYRATION RADIUS CORRECTIONS. Russell M. Kulsrud (Princeton Univ., N. J. Plasma Physical Lab.). Mar. 1964. Contract AT(30-1)-1238. 20p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

The effect of a first-order ion-gyration-radius correction on the growth rates of resistive instabilities is investigated. It is found that, if the electrons are treated as a fluid, this correction may be made by replacing the ion mass velocity by the E × B drift and adding a single term to the basic equations. The resulting modified dispersion relation for these instabilities is given and its consequences in certain limiting situations are developed. It is found that contrary to the result of infinite-conductivity instabilities, the resistive instabilities cannot be stabilized. They are only slowed down moderately and made overstable by this correction. (auth)

23824 (NP-14890) MAGNETIC FIELD ANNIHILATION. H. E. Petschek (Avco-Everett Research Lab., Everett, Mass.). Oct. 1963. Contract Nonr-2524(00). 36p. (AMP-123)

A mechanism for the rate of annihilation of magnetic field at the boundary between two regions of plasma containing oppositely directed field lines is examined. It is pointed out that previous analyses overlooked standing magnetohydrodynamic waves as a possible mechanism for converting magnetic energy to plasma energy. An estimate of the annihilation rate including such waves is made. Using this rate it is found that the energy required for a flare can be released in 10^2 sec. This time is short enough to account for the observed solar flare times if the source of the flare energy is stored magnetic energy. (auth)

23825 (NP-14917) DIAGNOSTIC EXPERIMENTS IN A MAGNETICALLY DRIVEN SHOCK TUBE. Technical Report 428. John B. Heywood (Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.). Jan. 1965. Contracts DA36-039-AMC-03200(E); and Nonr-1841(93). 62p.

Experiments are described in hydrogen in a magnetic annular shock tube with an applied axial magnetic field. Measurements of the front speed were made over as wide a range of initial gas pressure, initial drive band voltage and axial magnetic field as possible. These results are compared with the predicted speeds obtained from the Kemp and Petschek solutions and the snowplow model, and agreement is obtained. Measurements were also made on the front properties with magnetic and electric field probes inside the annulus, and with phototubes. It was found that a substantial fraction of the drive current always flows in the front and no shock wave preceding the current sheet was observed. A detailed picture of the current distribution inside the annulus is obtained, and a current loop was found to flow behind the front. Electric field measurements substantiate this picture. It is shown that when the Alfvén speed ahead of the front is comparable with the front speed, the flow pattern changes significantly. (auth)

23826 (R64SD90) CRITERIA FOR THE VALIDITY OF LOCAL THERMODYNAMIC EQUILIBRIUM. D. H. Sampson (General Electric Co., King of Prussia, Pa. Space Sciences Lab.). Dec. 1964. 25p.

With the use of formulas for the collisional excitation and ionization cross sections, a simple equation is obtained giving the relation between the electron temperature T, electron density N_e, and the ionization energy $I_{l'}$, required for a gas to be collision-dominated (here l' refers to the most tightly bound level of importance for a given N_e and T.). Then with the use of an approximate equation expressing $I_{l'}$ in terms of T and N_e, an approximate general equation giving the relation between T and N_e necessary for all elements to be collision-dominated is obtained. It is seen that at high temperatures very high electron densities are required for high-Z elements to be collision dominated. The additional requirements for a nonoptically thin gas to

be in LTE and the conditions for an optically thick gas to be in LTE are also briefly discussed. (auth)

23827 (SSD-TDR-64-267) TRANSMISSION AND REFLECTION OF ELECTROMAGNETIC WAVES BY A HOT PLASMA. E. C. Taylor (Aerospace Corp., El Segundo, Calif.). Nov. 30, 1964. Contract AF04(695)-469. 31p. (TDR-469(5220-10)-3)

The relativistic form of the Vlasov equation is used to solve the problem of transmission and reflection of normally incident electromagnetic waves. Transmission and reflection coefficients are derived for a plasma half-space and for a plasma slab, using the assumption that electrons are specularly reflected at the boundaries. These coefficients are functions of the ratio of the electron thermal speed to the vacuum speed of light, indicating that temperature dependence in these cases is a relativistic effect. Nevertheless, it is seen that the nonrelativistic limits of these coefficients differ from those obtained by using the cold-plasma equations since the transition to the zero-temperature limit has a nonuniform character. (auth)

23828 (TID-21499) ION BEAM-PLASMA INTERACTION. Final Report, July 15, 1960–August 31, 1964. (Florida. Univ., Gainesville. Dept. of Physics and Astronomy). Contract AT(40-1)-2783. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Research on ion beam interaction with plasma as distinct from that due to an electron beam interaction is reported. A number of related and supporting phases of the work were completed. Analytical work resulted in a better understanding of the ion beam behavior and beam instability in general. A new approach to the development of ion beam sources was made with new insight gained regarding those factors which ordinarily limit ion sources. The rate of formation of plasma in magnetic fields was investigated by breakdown measurements which indicate plasma beam properties. Measurements and analyses established new electron ionization coefficients in strong electric and magnetic fields. (J.R.D.)

23829 (TID-21548) QUARTERLY PROGRESS REPORT [ON PLASMA PRODUCTION], OCTOBER 6, 1964 TO JANUARY 5, 1965. A. V. Phelps (Westinghouse Electric Corp., Pittsburgh, Pa. Research Lab.). Feb. 15, 1965. Contract AT(30-1)-3472. 5p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Research directed toward production of plasma by irradiation of unsupported, condensed material using high-power pulsed lasers, and to measure the plasma confinement in magnetic mirrors and magnetic cusp geometries is reported. Discussions are included concerning laser design, construction, and testing. Discussions are also included on plasma production and confinement, vacuum-systems, and diagnostics. (J.R.D.)

23830 (UCRL-12325) MECHANICAL DESIGN FOR PLASMA PHYSICS RESEARCH. W. S. Neef, Jr. (Lawrence Radiation Lab., Univ. of California, Livermore). Jan. 14, 1965. Contract W-7405-eng-48. 33p. Dep.; $2.00(cy), 1(mn) CFSTI.

The major mechanical engineering requirements for plasma physics experiments are reviewed. The Alice machine at Lawrence Radiation Laboratory, a neutral injection experiment, is reviewed as a mechanical design study. Topics emphasized are magnet design and fabrication, beam source design, both analysis and experiment, vacuum pumps, valves, and seals for ultrahigh vacuum conditions, mechanical problems encountered with diagnostic tools, and materials and fabrication techniques. A survey of new techniques in cryopumping is followed by a discussion of the "minimum B" magnetic fields, including both Ioffe bars and "baseball seam" conductor shapes. (auth)

23831 (AEC-tr-6527) PLASMA PHYSICS AND PROBLEMS OF CONTROLLED NUCLEAR FUSION, CONFERENCE PROCEEDINGS, KHARKOV, NOVEMBER 14–19, 1960. Translation of "Fizika Plazmy i Problemy Upravlyaemogo Termoyadernogo Sinteza. Doklady Vtoroi Konferentsii po Fizike Plazmy i Probleme Upravlyamogo Termoyadernogo Sinteza, Khar'kov, 14–19 Noyabrya 1960," (a publication of the Publishing House of the Academy of Sciences of the Ukrainian, SSR, Kiev, 1963). 456. Dep.; $7.56(cy), 7(mn) CFSTI.

High-frequency characteristics of plasma, interactions of beams of charged particles with plasma and plasma stability, magnetohydrodynamics and shock waves in plasma, investigation of plasmoids, magnetic traps, gas discharges, and plasma diagnostics are discussed. Separate abstracts are prepared for 4 of the 35 papers presented. Abstracts of 31 papers previously appeared in NSA (15: 15175, 16: 3771, 4922, 5829, 17210, 19862, 28301, 28304, 31158, 17: 22730, 18: 483, 513, 1147, 1148, 1150, 1152 through 1156, and 1158 through 1168). (C.E.S.)

For abstracts of individual papers see: 23832, 23833, 23834, and 23835.

23832 (AEC-tr-6527(p.51-89)) MAGNETIC BREMSSTRAHLUNG OF PLASMA ELECTRONS. V. I. Pakhomov, V. F. Aleksin, and K. N. Stepanov. (Translation).

A determination is made, on the basis of kinetic theory, of the energy losses of nonrelativistic electrons moving along a spiral in plasma. It is assumed that the average thermal velocity of plasma electrons is considerably lower than the velocity of light. General expressions are derived for the electric and magnetic fields set up by the electron, which are utilized for calculating the intensity of magnetic-bremsstrahlung of fundamental frequency (s = 1) and of multiple frequencies (s = 2,3, . . .). The absorption of energy brought about by the occurrence of thermal motion of plasma electrons is taken into account. By means of the expressions derived for radiation intensity of an individual electron the emission and the absorption capacities of plasma for frequencies close to ω_s were determined. (C.E.S.)

23833 (AEC-tr-6527(p.169-82)) LOW-FREQUENCY PLASMA OSCILLATIONS IN A MAGNETIC FIELD. V. D. Fedorchenko, B. N. Rutkevich, V. I. Muratov, and B. M. Chernyi. (Translation).

Electron injection into a magnetic trap with spatial modulation of the magnetic field was studied. At pressures of the order of 10^{-6} mm Hg, in the circuit of the collector located past the magnetic plug at the exit from the trap, oscillations having a frequency of hundreds of kilocycles were observed. A study of the oscillations in the trap showed that they are very similar to low-frequency oscillations in electron beams. The results of studies of this phenomena with electron beams are outlined. (C.E.S.)

23834 (AEC-tr-6527(p.367-72)) EXPERIMENTAL DETERMINATION OF THE REGION OF MAGNETIC SURFACES BOUNDED BY A SEPARATRIX. B. P. Il'enko and V. G. Zykov. (Translation).

The concept of a separatrix which divides two classes of magnetic surfaces is considered. The first class of magnetic surfaces includes closed surfaces encompassing the axis of the system (Z axis), while the second class of magnetic surfaces closes around conductors of a stellarator winding. There exists a region, bounded by the separatrix, in which the charged particles on moving along the magnetic lines of force should not depart upon the chamber wall. An attempt was made to determine experimentally the region bounded by the separatrix, as a function of the longitudinal magnetic field and of the current in the stellarator winding. A model in which the role of the plasma is played by an electron beam was used. (C.E.S.)

23835 (AEC-tr-6527(p.437-46)) ON MEASUREMENT OF THE PARAMETERS OF PLASMA IN A MAGNETIC FIELD. L. V. Dubovoi and A. G. Ponomarenko. (Translation).

The interaction of electromagnetic waves of low amplitude with ionized media is applied for the study of basic processes in gas discharge. By direct measurements of characteristics of wave propagation the electron density, electron collision frequency, and the electron temperature can be determined. A description of the experiment and the results obtained for electrodeless discharges in hydrogen and argon are presented. (C.E.S.)

23836 (UCRL-Trans-1185(L)) INVESTIGATIONS OF PLASMA HEATING BY SHOCK WAVES IN MAGNETIC MIRROR TRAPS. Yu. E. Nesterikhin (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt (Univ. of California Lawrence Radiation Lab., Livermore). 1964. 51p. Dep.(mn); $3.00(cy), 1(mn) CFSTI; $5.60(fs), $1.73(mf) JCL.

A theoretical study is made of the heating of ions in trapped, initially cold plasma by fast shock waves. (T.F.H.)

23837 ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS. VOLUME 20. L. Marton, ed. Advan. Electron. Electron Phys., 20: 1-332(1964). New York, Academic Press.

Separate abstracts were prepared for three of the six papers included. The remaining papers deal with flame plasmas, tropospheric radio-wave propagation, and electronic aids for the blind. (D.C.W.)

For abstracts of individual papers see: 23236, 23838, and 23839.

23838 ELECTRONS AS A HYDRODYNAMICAL FLUID Richard G. Fowler (Univ. of Oklahoma, Norman). Advan. Electron. Electron Phys., 20: 1-58(1964).

The hydrodynamic theory of electrons and plasma is outlined, with particular consideration of the electric shock tube. The experimental bases for the theory are also considered, together with observations on shock tube phenomena. A survey of experimental plasmadynamical situations is included, covering magnetic drives, electromagnetic shock tubes, and small-amplitude waves. 93 references. (D.C.W.)

23839 PLASMA OSCILLATIONS. K. G. Emeleus (Queen's Univ., Belfast). Advan. Electron. Electron Phys., 20: 59-98(1964).

The theory of plasma oscillations is outlined, and experimental observations on spontaneous and stimulated oscillations are reviewed. The effects of magnetic fields, radiation from plasmas, sheath oscillations, and the use of probes in oscillating discharges are also briefly considered. 118 references. (D.C.W.)

23840 STUDY OF FLUCTUATIONS IN AN ARC PLASMAJET USING ELECTROMAGNETIC INDUCTION. Allen E. Fuhs (Aerospace Corp., El Segundo, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 3: 482-5(Mar. 1965).

The interaction of a fluctuating conducting gas with a steady applied magnetic field drives fluctuating currents. The unsteady magnetic field arising from these currents induces a voltage V in a sensing coil. An integral equation for V and the related partial differential equation for the electrical potential ϕ are derived. A relation between the signal rms magnitude and jet properties is discussed. Experiments were conducted using an arc plasmajet operating with argon. Most of the signal was due to frequency components in the interval 10 to 100 kc. By use of two transducers, one located downstream of the other, the average jet velocity was measured. The delay giving the peak value of the cross-correlation function formed from the two signals was taken as the transit time. Methods for electronically determining the time delay are described. (auth)

23841 INTERPRETATION OF DISPERSION EQUATIONS. INSTABILITY, AMPLIFICATION AND ABSORPTION. G. Convert. Ann. Radioelec., 19: 300-20(Oct. 1964). (In French)

The dispersion-equation approach to the description of the properties of a continuous homogeneous medium is outlined, with particular consideration of stability, amplification, and absorption. (D.C.W.)

23842 SMALL-TIME SOLUTION OF SNOWPLOUGH EQUATIONS FOR A PLASMA ACCELERATOR. Jon Arne Bakken. Arbok Univ. i Bergen, Mat.-Nat. Ser., No. 4, 1-14 (1964).

The snowplow equations for an idealized plasma accelerator energized from a condenser bank are solved with respect to current and current-sheet position to the second order of a characteristic parameter S. Approximate small-time formulas are given. Dimensionless variables are employed. Ohmic losses are neglected. (auth)

23843 CALCULATIONS ON AN ELECTROMAGNETIC SHOCK TUBE WITH A TRANSMISSION LINE ENERGY SOURCE. J. A. Bakken (Univ. of Bergen, Norway). Arbok Univ. i Bergen, Mat.-Nat. Ser., No. 16, 1-15(1965).

Calculations are done on an electromagnetic shock tube energized from a charged transmission line. The discharge current and the current sheet position are given as functions of time for small values of a characteristic parameter. Dimensionless analysis is carried out for the free-particle and the snowplow models of interaction between a moving current sheet and cold gas. (auth)

23844 EXPERIMENT ON A HIGH-CURRENT DISCHARGE AT ATMOSPHERIC PRESSURE. Erik A. Smårs (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 29: 97-133(1965).

A gas discharge between two plane electrodes initially at atmospheric pressure is studied. The current rises at about 10^{11} amp/sec to a peak value of about 10^5 amp. Most observations are made in hydrogen gas, some in helium, and a few in nitrogen. Special attention is paid to the initial phase. A thin channel in the gas is preionized by a vortex-stabilized d-c arc in the 1 amp range. Streak and Kerr-cell camera pictures show that the following heavy discharge depends very much on the state of the preionized path. If this path is sufficiently narrow the main discharge contracts by magnetic pinching and is turned into a helix by the spiral (m = 1) instability. The exponential growth rate is of the order $3 \cdot 10^7$ sec^{-1} and agrees with pinch instability theory. Time resolved spectra show that the hot plasma is free from impurities during the first half cycle (2 μsec). Relative intensities of spectral lines from O V and O VI (0.7 per cent CO_2 added to the gas) indicate a temperature near 1.6×10^5°K at maximum contraction, when the current is 10-30 k amp. The particle density has then increased to $10^{25}-10^{26}$ m^{-3}. (auth)

23845 NEW INVESTIGATIONS IN THE FIELD OF THERMONUCLEAR FUSION. H. Voelcker (Gutehoffnungshutte Sterkrade AG, Oberhausen, Ger.). Atomkernenergie, 10: 1-9(Jan.-Feb. 1965). (In German)

The most significant advances in the field of controlled thermonuclear fusion since 1958 are reviewed. (D.C.W.)

23846 THE WAVE FRONTS IN MAGNETOFLUIDDYNAMICS. Italo Ferrari (Universita, Modena, Italy). Atti Seminar. Mat. Fis. Univ. Modena, 13: 4-25(1964). (In Italian)

The equations describing the wave fronts in magnetofluiddynamics are derived in a continuation of studies by Nardini and Agostinelli. The general case is considered first, and then the particular cases $H_t = 0$, $H_n = 0$, and $v = 0$ are calculated. The equations for isothermal incompressible fluids are derived in conclusion. (J.S.R.)

23847 THE INFLUENCE OF NON-LINEAR TERMS ON THE PROPAGATION OF WAVES IN AN IONIZED GAS. Giovanna Ridolfi (Universita, Bologna). Atti Seminar. Mat. Fis. Univ. Modena, 13: 98-110(1964). (In Italian)

The influence of the inertial terms on the propagation of electromagnetic waves is considered for the particular case of the propagation of plane waves in the vicinity of the wave front when $H_0 \neq 0$. The effects on the longitudinal and transverse components of the field are determined. (J.S.R.)

23848 MONTE CARLO CALCULATIONS OF THE RADIAL DISTRIBUTION FUNCTIONS FOR PROTON-ELECTRON PLASMA. A. A. Barker (Univ. of Adelaide). Australian J. Phys., 18: 119-33(Apr. 1965).

A general method is presented for computation of radial distribution functions for plasmas over a wide range of temperatures and densities. The method uses the Monte Carlo technique applied by Wood and Parker, extending it to long-range forces using results borrowed from crystal lattice theory. The approach is then used to calculate the radial distribution functions for a proton-electron plasma of density 10^{18} electrons/cm^3 at a temperature of 10^4°K. The results show the usefulness of the method if adequate computing facilities are available. (auth)

23849 ON THE OSCILLATIONS OF A WEAKLY INHOMOGENEOUS PLASMA. Som Krishan (Univ. of Delhi). Can. J. Phys., 43: 640-4(Apr. 1965).

Oscillations of a collisionless plasma in equilibrium with a magnetic field, which is weakly inhomogeneous in one dimension, were studied. The calculations were based on longitudinal oscillations, i.e., the electric vector was parallel to the wave vector. The procedure employed was to use Maxwell's equations and expand the velocity distribution function about its equilibrium value for finding the perturbation in the distribution. The dispersion relation so obtained was different from that of Rosenbluth et al. (1962). The system was stable for the small Landau growth rate (Landau 1946), which might become appreciable for wavelengths comparable with the Larmor radius, provided $k \simeq \epsilon$, where k is the wave vector and ϵ is a small inhomogeneity parameter. (auth)

23850 THE EFFECT OF FINITE CONDUCTIVITY ON GRAVITY WAVES IN A HORIZONTAL MAGNETIC FIELD. R. A. Wentzell and J. H. Blackwell (Univ. of Western Ontario, London). Can. J. Phys., 43: 645-52(Apr. 1965).

A study was made of the behavior of the plane interface between a vacuum and an electrically conducting fluid subject to a normal gravitational force and a magnetic field parallel to the interface. The system was examined for perturbations, which bend the lines of force, without restriction to the extensively used idealization of infinite electrical conductivity. The eigenvalue spectra obtained, which were surprisingly different from the simpler ones corresponding to infinite conductivity, were examined by approximate and numerical techniques over the complete range of electrical conductivity from infinity to zero. The disappearance of a normal mode solution above a critical value of conductivity is a feature of the effect of finite conductivity on magnetohydrodynamic stability. (auth)

23851 STUDY OF THE STABILITY OF CYLINDRICAL PINCHES IN THE VLASOV MODEL. Guy Laval and René Pellat (Euratom-CEA, Fontenay-aux-Roses, France). Compt. Rend., 260: 837-40(Jan. 18, 1965). (In French)

The stability of plasma–electromagnetic field systems was studied by neglecting the radiation, that is the flux of the Poynting vector. The electromagnetic field is described by the Maxwell equations and the plasma by the Vlasov equation. The method consists in studying the linear perturbations of the system that conserves its energy. The case of two experimental situations actually studied was considered in cylindrical geometry: tubular pinch (hard-core pinch) and azimuthal pinch (theta pinch). (tr-auth)

23852 COUPLING OF A CYLINDRICAL PLASMA TO A WAVE GUIDE. Brian Gragory and Georges Mourier (C.S.F.-C.E.P.E.C., Domaine de Corbeville, Orsay, France). Compt. Rend., 260: 1592-5(Feb. 8, 1965). (In French)

The impedance presented in a wave guide by a positive column contained in a glass tube perpendicular to the electric field and excited around the dipolar electrostatic transverse resonance was calculated by an equivalent scheme. The theoretical and experimental results are compared. (tr-auth)

23853 THE RANGE OF EXISTENCE OF PLASMOIDS CREATED BY RARE GASES BY HIGH FREQUENCY ELECTRIC DISCHARGES. Jean Bacri, Pierre Benoit-Cattin, Daniel Blanc, Rene Dagnac, and Jean Ferre (Centre de Physique Nucleaire de la Faculte des Sciences, Toulouse). Compt. Rend., 260: 1596-8(Feb. 8, 1965). (In French)

The region of the pressures for which stable plasmoids exist was determined. The discharge was maintained by a field of 50 MH_z applied between two plane and parallel exterior electrodes. The measurements were made on helium, neon, argon, and xenon; the region does not depend on the nature of the rare gas. (tr-auth)

23854 PROPAGATION OF ULTRASONIC WAVES IN PLASMAS. P. Venkatarangan (National Aeronautical Lab., Bangalore, India). Current Sci. (India), 33: 551(Sept. 20, 1964).

Dispersion relations for the interaction of ultrasonic waves with isothermal and nonisothermal plasmas were obtained previously, for the case where the ion atomic number is unity. The treatment is extended for the case of any ion charge, and the results are presented. The expressions derived show that the electron temperature is inversely proportional to the ion charge. (BBB)

23855 MEASUREMENT OF VELOCITY OF SHOCK WAVE IN PLASMA. J. Tobias and J. Kravarik (Czech. Tech. Univ., Prague). Czech. J. Phys., 15: 236-40(1965).

A method of exciting a shock wave in a T-shaped discharge tube is described. It gives the results of measuring the rate of propagation of a shock wave in air, helium, and krypton in a pressure range of 10^{-2}–1 torr. It also gives the oscillograms of the discharge current, voltage, and time derivative of the current and calculates some of the characteristic properties of the circuit, part of which is the exciting discharge. (auth)

23856 ELECTROSTATIC MASS SPECTROMETER FOR ANALYSIS OF PLASMA DENSITIES. H. Hartnagel (Univ. of Sheffield, Eng.). Electron. Letters, 1: 4-5(Mar. 1965).

An electrostatic mass spectrometer is described which can be used for measurements of the mass spectrum of plasma ion density as a function of radius. Coarse measurements are made by changes of frequency and fine ones by amplitude changes of voltage pulses. (auth)

23857 SURFACE-WAVE PROBE FOR MEASURING ELECTRON DENSITIES IN A GASEOUS PLASMA. P. N. Robson and R. D. Stewart (Univ. of Sheffield, Eng.). Electron. Letters, 1: 13-14(Mar. 1965).

A dielectric rod enveloped in a gaseous plasma can act as a supporting structure for electromagnetic surface waves. The dielectric constant of the plasma and hence the electron number density in the vicinity of the rod may be determined from measurements of the phase-change coefficient of the EH_{11} mode supported by the plasma-clad rod. Measurements of radial density distribution were carried out in an unmagnetized argon afterglow plasma at 35 Gc/s and compared with double-probe measurements. (auth)

23858 GUIDED WAVES ON A DIELECTRIC-COATED CYLINDER IMMERSED IN A PLASMA. S. R. Seshadri (Sylvania Electronic Systems, Waltham, Mass.). Electron. Letters, 1: 19(Mar. 1965).

The dominant circularly symmetric TM surface-wave mode on a Goubau wire immersed in an isotropic plasma is shown to have a low-frequency cutoff, in contrast to its free-space counterpart, for which the propagation extends down to zero frequency. (auth)

23859 EFFECTS OF ELECTRON-DENSITY DISTRIBUTION ON THE BACK SCATTERING FROM AN ANISOTROPIC PLASMA CYLINDER. C. Yeh and W. V. T. Rusch (Univ. of Southern California, Los Angeles). Electron. Letters, 1: 25(Mar. 1965).

The backscattering cross section of a radially inhomogeneous plasma cylinder with an impressed axial static magnetic field is obtained for an incident H wave. The electron-density distribution is assumed to have a parabolic profile. Significant variation of the backscattering cross section as a function of the density profile is found. (auth)

23860 DEVICE FOR INVESTIGATION OF ALKALI PLASMAS. N. S. Buchel'nikova (Inst. of Nuclear Physics, Academy of Sciences, Siberian SSR). High Temp. (USSR) (English Transl.), 2: 279-81 (May-June 1964). Translated from Teplofiz. Vysokikh Temp., 2: 309-12(May-June 1964).

An apparatus is described with which alkali (Cs or K) plasmas in the density range from 10^8 to 5×10^{11} cm^{-3} can be produced with a high degree of ionization. (D.C.W.)

23861 BEHAVIOR OF AN ARGON–CESIUM PLASMA IN AN ELECTRIC FIELD. V. A. Abramov and Yu. A. Tarasov. High Temp. (USSR) (English Transl.), 2: 282-7 (May-June 1964). Translated from Teplofiz. Vysokikh Temp., 2: 313-20(May-June 1964).

The production of nonequilibrium ionization in the channel of a MHD generator in which an Ar–Cs plasma is placed in a steady (or alternating) electric field is studied. Estimates are given for the field needed to heat the electrons to 3000 to 4000°K. Allowance is made for radiation losses and for losses arising by elastic collision of the electrons with neutral atoms in relation to the total electrical losses. Optimal values are deduced for the conductivity of the plasma for various Cs concentrations and Ar pressures at 3000 to 4000°K. (auth)

23862 AN APPROACH TO UNSTEADY ONE-DIMENSIONAL MAGNETO-GAS-DYNAMIC PROBLEMS. E. Levi and M. Sandler (Brooklyn Polytechnic Inst.). High Temp. (USSR) (English Transl.), 2: 318-27(May-June 1964). Translated from Teplofiz. Vysokikh Temp., 2: 351-8(May-June 1964).

Two techniques are proposed for the solution of unsteady one-dimensional MHD problems. The first applies to situations in which the ionized gas can be idealized by neglecting dissipative effects. It leads to closed form solutions which can be used, for example, to study the development of a large scale disturbance and the formation of a shock; this application is demonstrated. The second technique applies, in general, when electromagnetic and heat diffusion, as well as viscosity effects, must be taken into account. It leads to a finite difference scheme, which is particularly suitable for numerical computations in that it strikes a balance between the opposing requirements of simplicity and stability. (auth)

23863 COUPLING OF ELECTROMAGNETIC ENERGY TO A BOUNDED ONE-DIMENSIONAL INHOMOGENEOUS PLASMA. S. V. Yadavalli (Stanford Research Inst., Menlo Park, Calif.). Intern. J. Electron. (1), 18: 1-22(Jan. 1965).

The problem of coupling of electromagnetic energy to a one-dimensional inhomogeneous plasma bounded on one side by a metallic conductor is discussed in detail using the linearized hydrodynamic approach. The existence and effects of coupling of transverse electromagnetic and longitudinal plasma waves are explored. It is interpreted that under the influence of incident electromagnetic energy, the plasma sheath, when lossy, expands. It is shown that under some conditions a type of surface wave may be excited and also that in some cases a portion of the energy coupled to the plasma electrons is carried away when a (plasma) flow is present. (auth)

23864 THE EFFECT OF CONVECTIVE INSTABILITIES ON THE LONGITUDINAL RF IMPEDANCE OF A ONE-DIMENSIONAL BEAM-PLASMA SYSTEM. G. Guest (Oak Ridge National Lab., Tenn.). Intern. J. Electron. (1), 18: 147-57(Feb. 1965).

An elementary derivation is given of a closed form expression for the impedance of a pair of ideal plane grids immersed in a beam-plasma medium such that the beam velocity is perpendicular to the plane of the grids. Numerical examples are given to illustrate the dependence of this impedance on frequency and grid separation. (auth)

23865 ON RADIATION OF CHARGE MOVING IN A MEDIUM WITH FLUCTUATING PARAMETERS. V. V. Tamoikin (Gorkii State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1057-63(1964). (In Russian)

A study is made of the radiation of a charge moving in a gas with thermodynamic fluctuations of pressure and entropy and also in a plasma with thermal fluctuations of electron density. It is shown that the spectral density of emission of electromagnetic waves may be less than the radiated energy for the motion of the charge in an irregular inhomogeneous medium with parameters independent of time. (auth)

23866 COHERENT BREMSSTRAHLUNG OF EXTENDED ELECTRON CLUSTERS. G. A. Alekseev and P. V. Bliokh (Inst. of Radiophysics and Electronics, Ukrainian SSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1064-74(1964). (In Russian)

Bremsstrahlung of electron clusters of arbitrary dimensions and shape is considered. It is shown that for each point of observation there exists a surface on which the charges radiate coherently into the point of observation. A calculation is made of the directional distribution of the emitted power of a succession of electron clusters having the form of a parallelepiped. (auth)

23867 TO THE THEORY OF NONLINEAR INTERACTION OF TRANSVERSE AND LONGITUDINAL PLASMA WAVES. A. Gaylitis and V. N. Tsytovich (Lebedev Inst. of Physics, Moscow). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1190-3(1964). (In Russian)

It is shown that the nonlinear interaction of longitudinal and transverse plasma waves can be significant and in some cases more important than the interaction of longitudinal waves with one another . The nonlinear interaction of transverse and longitudinal plasma waves with frequencies near the Langmuir-oscillation frequency is studied for an isotropic plasma. Expressions describing the nonlinear effects are obtained using equations for the scattering probability of a longitudinal wave on a particle, with transformation into a transverse wave, for thermal particles and nonrelativistic plasma waves, taking interference effects and transition radiation into account. (M.J.T.)

23868 ON INFLUENCE OF RADIATION UPON THE RESONANCE ACCELERATION OF PARTICLE IN PLANE WAVE FIELD. V. B. Krasovitskii and V. I. Kurilko. Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1193-5(1964). (In Russian)

The effect of radiation on the acceleration of a particle in a self-resonant condition is considered. The equations of motion are used to obtain an expression for the phase of the particle velocity relative to the wave field. It is found that basically the action of the radiation produces mixing of the phase of the particle velocity with respect to the field and disturbance of the synchronism. The strength of the radioinduced deceleration can change for the case of the motion of charged-particle clusters as a result of coherent radiation. The calculation of the coherent interaction between a series of clusters, for distance between clusters equal to or shorter than the accelerating field wavelength, is outlined. An infinite number of nonrelativistic particles, distributed periodically over a distance equal to the wavelength and interacting in phase, are considered as an example. (M.J.T.)

23869 TO NONLINEAR THEORY OF ELECTROMAGNETIC WAVES IN SEMICONDUCTORS AND PLASMA. F. G. Bass and S. I. Khankina (Inst. of Radiophysics and Electronics, Ukrainian SSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1195-8(1964). (In Russian)

A study is made of the distribution and absorption of strong electromagnetic waves in semiconductors and plasma, assuming that the relations $|\omega - \omega_H| \gg \nu$, $\omega, \omega_H \gg \nu$ exist among the frequency of the diffusing field ω, the Langmuir frequency ω_H, and the collision frequency ν. It is assumed also the relaxation time as a function of energy τ and the frequency of the decaying field ω are connected by $\omega\tau \gg 1$. The expression for the distribution function of current carriers is given. The complete system of equations for the case of a monochromatic wave consists of the Maxwell equations for a magnetoactive plasma and the temperature equation. The cases are considered of Alfvén waves bounded by the diffusion of the wave along the magnetic field, of the hybrid resonance arising in the presence of two types of carrier with diffusion of the wave perpendicular to the magnetic field, and of the diffusion of low-frequency spiral waves in semiconductors with one type of carrier. (M.J.T.)

23870 NORMAL WAVES IN CIRCULAR WAVEGUIDE FILLED WITH PLASMA, SPATIAL DISPERSION BEING TAKEN INTO ACCOUNT. V. Ya. Eidman (Gorkii State Univ.). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1214-16(1964). (In Russian)

To clarify phenomena occurring in a plasma in a closed system, the problem of normal waves in a circular waveguide filled with isotropic plasma is considered, taking weak spatial dispersion into account. Also the question is studied of the emission of these waves by very simple sources: by an oscillator oriented parallel to the axis

of the waveguide and by a charge moving with constant velocity along the waveguide axis. (M.J.T.)

23871 EXPERIMENTAL INVESTIGATION OF SPACE CHARGE IN CYLINDRICAL MAGNETRON IN A STATIC REGIME. L. M. Groshkov (Gorkii State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 1217-22 (1964). (In Russian)

An attempt was made to study experimentally the space charge in the upper part of the electron cloud of a magnetron by the method of electron-optical examination. A second longitudinal probing electron beam was introduced into the magnetron at some distance from the cathode. The deflection of this beam in the electric field, observed on a fluorescent screen, permitted the potential distribution to be evaluated. Pictures comparing experimental observations with calculated trajectories of the probe beams are given for various values of magnetic field and electric potential. (M.J.T.)

23872 STRIATION PRODUCTION DURING ELECTRICAL BREAKDOWN IN HYDROGEN. R. H. Neusel and M. Silver (TRW Space Technology Labs., Inc., Redondo Beach, Calif.). J. Appl. Phys., 36: 1507-9(May 1965).

Striations, with an average lifetime of about 5 μsec, were observed during the initial phase of electrical breakdown in H_2, at pressures ranging from 3 to 50 torr, and with 2.5 kv applied across a 5-mm gap. The striations were observed to propagate towards the cathode at about 10^4 cm/sec, but the rate of advance of the appearance point of the striations was at least four times faster and towards the anode. (auth)

23873 ROTATING ION PLASMA IN AN EXTERNAL MAGNETIC FIELD. Nak Goo Kim (Maremont Corp., Pasadena, Calif.). J. Appl. Phys., 36: 1611-12(May 1965).

The Vlasov equation is investigated for the case of an ionized gas rotating in a uniform external magnetic field. The distribution function for a cylinder is obtained neglecting particle-particle collisions. The rotation of the ion beam is related to the Larmor and the plasma ion frequencies with resonance when $\omega_1^2/\omega^2 = 2$, where ω_1 and ω are the ion plasma and angular frequencies. (auth)

23874 EIGENVALUES OF A MICROWAVE-CAVITY-LOSSY-PLASMA SYSTEM. J. L. Shohet (Johns Hopkins Univ., Baltimore) and C. Moskowitz. J. Appl. Phys., 36: 1756-9(May 1965).

A cylindrical microwave cavity containing a concentric plasma column can be resonated in an infinite number of electromagnetic wave modes. The resonances all shift upward towards coaxial cavity modes as the electron density in the plasma is increased if collisions are neglected. The characteristic eigenvalue equation for all modes including collisional effects is derived and typical graphs for fundamental modes are presented. The solutions of the eigenvalue equation can be explained on the basis of coupled-mode theory. The empty cavity mode and the coaxial (infinite electron density) mode which are originally overcoupled, uncouple from each other for sufficiently large values of electron collision frequency. The imaginary part of the roots, which is inversely proportional to the Q of the plasma cavity system, shows the two modes distinctly. (auth)

23875 THE DISPERSION AND ATTENUATION OF HELICON WAVES IN A UNIFORM CYLINDRICAL PLASMA. J. P. Klozenberg, B. McNamara, and P. C. Thonemann (Culham Lab., Abingdon, Berks, Eng.). J. Fluid Mech., 21: 545-63(Mar. 1965). (CLM-P-55)

A systematic account is given of the derivation of the dispersion relation for helicon waves in a uniform cylindrical plasma bounded by a vacuum. By retaining finite resistivity in the equations, boundary conditions present no difficulties, since the wave magnetic field is continuous through the plasma-vacuum interface. Two unexpected results are found. First, the wave attenuation remains finite in the limit of vanishing resistivity. This is due to the energy dissipated at the interface by the surface currents required to match the plasma wave field to the vacuum wave field. Zero wave attenuation for zero resistivity is recovered if electron inertia is included. Secondly, it is found that waves with azimuthal numbers m of opposite sign propagate differently, but the sense of polarization at the axis of the cylinder is independent of the sign of m. The argument of the dispersion function is complex, and numerical results were obtained using a computer. The method of programming is described, and results are given applicable to propagation in metals at low temperatures, or in a typical gas discharge plasma for the m = 0 and m = ±1 modes. An example of the amplitude of the wave fields as a function of radius is given for the axisymmetric mode, and of amplitude and phase for the m = ±1 modes. (auth)

23876 ELECTRON HEATING BY HYBRID RESONANCES IN PLASMAS. Susumu Takeda (Nagoya Univ., Japan). J. Phys. Soc. Japan, 20: 287(Feb. 1965).

Electron hybrid resonance in He plasma was observed by the reflected power of high-power pulsed microwave band. Pictures of the light-intensity increase at various magnetic fields during the pulses are presented, and the high electron density and efficient electron heating by resonance absorption are pointed out. (M.J.T.)

23877 MICROWAVE RESONANCE IN AFTER-GLOW PLASMA. Goro Matsuo (Asahi Broadcasting Co., Japan), Mikio Takeyama, and Kenji Mitani. J. Phys. Soc. Japan, 20: 288-9(Feb. 1965).

The resonance probe method with a fixed microwave signal was investigated using the variable electron density of an Ar afterglow plasma. The electron density at the observed microwave resonances was measured and found in fairly good agreement with predictions based on plasma resonance. (M.J.T.)

23878 THEORY OF HARMONIC GENERATION IN A GASEOUS PLASMA. Katsuji Chiyoda (Electrotechnical Lab., Tokyo). J. Phys. Soc. Japan, 20: 290-1(Feb. 1965).

The harmonic components of the distribution function of electrons in a gas under a uniform sinusoidal electric field are calculated, using the Boltzmann equation taking into consideration diffusion and ionizing collisions between electrons and gas molecules. The generation of harmonic radiation is discussed. (M.J.T.)

23879 PLASMA ION OSCILLATION IN A PLASMA-BEAM SYSTEM. K. Kato, K. Matsuura, and M. Yoseli (Electrotechnical Lab., Tokyo). J. Phys. Soc. Japan, 20: 443-8(Mar. 1965).

Plasma ion oscillations were studied in a plasma produced by a hot-cathode, mercury-vapor discharge, at a pressure of about 1 μHg. A superheterodyne detector and a movable probe were employed to observe frequency spectra at different points in a small tube having plane electrodes. The frequencies of the self-sustained plasma ion oscillations were markedly dependent on the position in the tube, and the frequencies of the ion oscillations on the inside of a beam were lower than on the outside. A simple theory of plasma ion oscillation in a plasma-beam system is proposed to explain the observations. (auth)

23880 A RESONANT SUPPRESSION OF LOW-FREQUENCY OSCILLATION IN PLASMA. Hiroshi Tanaca and Mikiko Hagi (Yokohama National Univ., Japan). J. Phys. Soc. Japan, 20: 458(Mar. 1965).

A wave in a Hg plasma was observed to be resonantly suppressed by an externally applied signal of the same frequency, with proper probe potential or electron-beam density amplitude. Phase shifts occurring near and at this resonant frequency are discussed. Production of an excited wave in the interaction between the external and plasma waves is considered. (M.J.T.)

23881 A LOW-FREQUENCY GLOBAL RESONANCE IN PLASMA. Hiroshi Tanaca and Mikiko Hagi (Yokohama National Univ., Japan). J. Phys. Soc. Japan, 20: 459(Mar. 1965).

A low-frequency resonance characteristic of plasma was examined in a Hg discharge, using excitation by an a-c ex-

ternal signal. The amplitudes of the resonance excited waves are shown to decrease with increasing discharge current; the resonance frequency increases with the discharge current and is independent of the external signal. Resonance excitation by subharmonics is discussed. (M.J.T.)

23882 MICROWAVE RADIATION NEAR ELECTRON CYCLOTRON HARMONICS. Shigetoshi Tanaka (Nagoya Univ., Japan), Hiroshi Kubo, and Kenji Mitani. J. Phys. Soc. Japan, 20: 462(Mar. 1965).

Microwave radiation from a plasma column near the harmonics of the electron cyclotron frequency was measured. It was found that the harmonic is accompanied by many small subsidiary resonance peaks at slightly higher magnetic field than the resonance itself. Results of radiated microwave power are given as a function of magnetic field and discharge current. (M.J.T.)

23883 THE PROPAGATION CHARACTERISTICS OF ELECTROHYDRODYNAMIC WAVE. K. Sakurai. Kaku Yugo Kenkyu, 10: 204-17(1963). (In Japanese)

It is pointed out that magnetically active plasmas are normally anisotropic media, and the equation for the alternating field is obtained by combining the equation for the current density of these media with the Maxwellian equations. The dispersion relation is derived and analyzed to obtain an expression for the phase velocity of the electrohydromagnetic wave. A normal wave and an anomalous wave is then defined, which have very dissimilar propagation characteristics. (L.B.S.)

23884 A HYDRODYNAMICAL MODEL FOR THE IRREVERSIBLE EXPANSION PROCESS IN THE B.S.G. (MACETLE) EXPERIMENT–CASE OF A UNIFORM MAGNETIC CHANNEL. Masatomo Sato and Shigeo Hamada (Nihon Univ., Tokyo). Kakuyugo-Kenkyu, 13: 473-92(Dec. 1964). (In Japanese)

The expansion of plasma into vacuum in a cylindrical tube, and the related problem of thermalization by the production of shock wave, are considered in a hydrodynamical model to obtain an overall picture of the irreversible expansion process in the B. S. G. (MACETLE) experiment. (auth)

23885 A RADIO FREQUENCY FOR DETERMINING PLASMA DENSITY. Takayoshi Okuda (Nagoya Univ., Japan). Kakuyugo-Kenkyu, 14: No. 1, 1-12(Jan. 1965).

A method for determining plasma density by use of a solenoid is proposed. The calculation of the distributions of the electric and magnetic field in a homogeneous plasma placed in the solenoid is made, and the current flowing in the solenoid or the impedance looking into the solenoid is expressed in terms of the plasma density. The method is to apply a r-f voltage across the solenoid and to measure the impedance by either a Lissajous' figure on a x-y scope or an impedance bridge. (NSA of Japan)

23886 CHARGED PARTICLE DENSITY DISTRIBUTION IN A COAXIAL PLASMA GUN. Suckki Be and Yoshei Nakano (Tokyo Inst. of Tech.). Kakuyuogo-Kenkyu, 14: No. 1, 58-63(Jan. 1965). (In Japanese)

The density distribution of charged particles in a coaxial plasma gun was obtained from measurements of the magnetic field distribution and the axial electric field in the gun. (NSA of Japan)

23887 REMARKS ON THE PROJECT FOR CONTROLLED ATOMIC NUCLEAR FUSION. Karl Nowak. Neue Physik, 4: 77-80(1964). (In German)

The opinion is prevalent that the temperature in a plasma must be maintained for at least 10^{-2} sec in order to produce fusion. This is true only if the most rapid particles within a Maxwellian velocity distribution possess the fusion velocity within a statistical time span. However, this is not a requirement if the "temperature movement" is caused by retroactive guidance of accelerated ions, and the voltage velocity of almost all ions is practically equal and are not distributed in a Maxwellian distribution. A "fusion time" need not be considered necessary in such cases. The "temperature value" should be selectable. For ions with a retroactive guidance velocity of two times 100 kv, it amounts to $\sim 1.5 \times 10^{9}$K. Another requirement for fusion is adequate magnetic fields relative to the compressibility of the plasma. Usually, a symmetrical temperature movement is imposed, so that excessive magnetic fields are necessary, and the contracted plasma becomes unstable. However, if the "temperature movement" is directed axially (the temperature gradient perpendicular to the direction of the magnetic field is less by a factor of ten) the compressibility is markedly increased. From this it appears directly that it should be possible to attain ion densities of more than $10^{16}/cm^3$, as desired, with the magnetic field strengths usually available. These could reach as high as $10^{18}/cm^3$. (BBB)

23888 ON THE NATURE OF PLASMA RESONANCE. W. M. Leavens (National Bureau of Standards, Boulder, Colo). Phys. Letters, 15: 310-11(Apr. 15, 1965).

Calculations on the nature of plasma resonance, which include Landau damping and do not impose unphysical boundary conditions, are presented. The problem solved is that of the steady, driven oscillations of a one-dimensional slab of Maxwellian plasma, thin compared to a free space wavelength, with a wall at X = 0 that emits electrons and absorbs all electrons that return to X = 0, and an insulated wall at $X = X_w$ that also absorbs electrons. The unperturbed electric field, everywhere in the positive x-direction is uniform in the plasma and joins smoothly to a harmonic oscillator field in the sheath. The plasma is excited by a uniform driving field in the x-direction. The ions are stationary and distributed so as to make the steady-state satisfy Poisson's equation. Collisions are neglected. This model corresponds to the cylinder problem or the problem of a two-sided slab of plasma provided that only negligible fields penetrate to X = 0. (C.E.S.)

23889 DAMPING OF COLLECTIVE EXCITATIONS IN NEARLY DEGENERATE TWO-COMPONENT PLASMAS. J. F. Prosser and M. J. Harrison (Michigan State Univ., East Lansing). Phys. Letters, 15: 315-16(Apr. 15, 1965).

A previously developed (M. J. Harrison, Int. J. Phys. Chem. Solids, 23: 1079(1962)) zero temperature theory of a two-component current-carrying plasma of electrons and holes is generalized. The effects of small finite temperatures on the stability of the acoustic modes and the damping of the high frequency modes were studied for the case of long wavelengths. (C.E.S.)

23890 RECOMBINATION OF IONS AND ELECTRONS IN A HIGHLY IONIZED HYDROGEN PLASMA. William S. Cooper, III, and Wulf B. Kunkel (Univ. of California, Berkeley). Phys. Rev., 138: A1022-7(May 17, 1965). (UCRL-11691)

A hydrogenic plasma with an electron density near 5×10^{15} cm^{-3} and a temperature between 1 and 3 ev is produced by a powerful transient discharge in a tube of 14-cm dia and 86-cm length. Spectroscopic techniques are used to follow the subsequent decay of both electron density and temperature for about 300 μsec. A strong uniform axial magnetic field suppresses rapid radial particle losses, but does not appreciably reduce the radial energy transport. The axial transport apparently results merely in the slow growth of relatively thin dense boundary layers at the tube ends. In the interior the ionization is shown to decay primarily by volume recombination, and the rate coefficient agrees well with that calculated by Bates, Kingston, and McWhirter for plasmas that are virtually opaque to the Lyman-line radiation. Evidently, the plasma starts out essentially fully ionized and seems to remain close to local thermal (Saha) equilibrium for 120 μsec. The inferred energy-loss rate, on the other hand, initially exceeds that expected for kinetic transport by perhaps an order of magnitude, indicating that early in the afterglow radiative transfer may be significant. (auth)

23891 LONGITUDINAL WAVE-PROPAGATION MODES ALONG A POSITIVE COLUMN. B. O'Brien (Max-Planck-Institut fur Physik und Astrophysik, Munich), R. W. Gould, and J. Parker. Phys. Rev. Letters, 14: 630-2(Apr. 19, 1965).

Measurements were made of the propagation of waves along the positive column of mercury discharge with characteristic velocities of the order of the speed of sound for the electron gas. The waves were excited by appropriate couplers in both dipole and rotationally symmetric modes, and transmission bands were investigated with a phase-sensitive receiver. The transmitted power was measured using a wave guide oriented so that the E field in the guide is not parallel to the earth's magnetic field. A theoretical dispersion curve was calculated and compared to experimental curves. (L.B.S.)

23892 STABILIZATION OF A CURRENT-CARRYING PLASMA BY WAVE-PARTICLE INTERACTION. Gary A. Pearson (Univ. of California, Berkeley) and Allan N. Kaufman. Phys. Rev. Letters, 14: 735-6(May 3, 1965).

The electron-velocity distribution in an electron-proton plasma subjected to a uniform static field E_θ is discussed. An explicit numerical solution of the Lenard and Balescu form of the Fokker-Planck equation confirmed the expectation that as E_θ approaches a critical value E_c the enhanced electron-electron interaction produces a change in the velocity distribution in such a direction as to make the plasma more stable, i.e., so as to increase the damping rates of those waves about to become unstable. (C.E.S.)

23893 TRANSMISSION AND REFLECTION COEFFICIENTS OF A BOUNDED PLASMA SLAB. T. D. Shockley, Jr. and M. L. Howe (Univ. of Oklahoma, Norman). Proc. IEEE (Inst. Elec. Electron. Engrs.), 53: 320(Mar. 1965).

The equations for the reflection and transmission coefficients of a bounded plasma slab on which a linearly polarized plane wave is obliquely incident are derived using wave matrices. (D.C.W.)

23894 TEMPERATURE DEPENDENCE OF THE PLASMA FREQUENCY OF AN ELECTRON GAS IN INTERACTION WITH THE PHONON FIELD. A. Corciovei and D. Grecu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 645-67(1964).

The temperature dependence of the dispersion relation between the frequency of plasma in a dense free electron gas, and the propagation vector is studied. The equations of motion of the one electron density matrix in random-phase approximation are used. Taking into account the coupling between the electrons and the thermal vibrations of the atomic lattice, the shifting of the frequency of plasma, or the shifting of the frequency of phonons owing to this coupling, is studied. The study is made of the modification, as an effect of the second perturbation order, of the frequency of plasma caused by the equilibrium vibrations of the atoms of the lattice. (auth)

23895 X-BAND WAVEGUIDE CELL FOR STUDY OF MICROWAVE PROPAGATION THROUGH MAGNETO-PLASMA. J. H. Noon, E. H. Holt, and J. F. Reynolds (Rensselaer Polytechnic Inst., Troy, N. Y.). Rev. Sci. Instr., 36: 622-5(May 1965).

A metal X-band waveguide cell was developed for studying microwave propagation through plasmas immersed in a longitudinal magnetic field. The cell consists of a length of circular waveguide mounted between turnstile junctions. Modification of these junctions permits the installation of discharge electrodes on the magnetic field axis. No glass cell is required. The discharge can be operated successfully at pressures in the range 0.25 to 1 torr. Measurements of the changes in the amplitudes of the circular components of the wave polarization, due to the presence of a magnetoplasma in the cell, allow the electron density and electron collision frequency to be calculated. (auth)

23896 MICROWAVE PLASMA DENSITOMETERS. H. A. Buckmaster (Univ. of Keele, Staffordshire, Eng.). Rev. Sci. Instr., 36: 711-12(May 1965).

A microwave system for studying density fluctuations in plasmas is described. (D.C.W.)

23897 CALCULATIONS OF MICROWAVE TRANSMISSION CHARACTERISTICS IN A GASEOUS PLASMA. Ichirou Taniguchi and Yoshihiko Kawamura. Sci. Eng. Rev. Doshisha Univ., 4: No. 2, 47-59(Nov. 1963). (In Japanese)

The study of microwave phase shift and attenuation produced by the interaction with a gaseous plasma is reported. The wave equation is solved by a series expansion method, and numerical calculations are achieved by the digital computer KDC-1. Some hypotheses, i.e., the one-dimensional model, the parabolic distribution of the electron density and the absence of a static magnetic field, are used. The technique may be easily expanded to the cases of more complicated distribution. The results of calculations, and a convenient chart for computing the collision frequencies and plasma frequencies from the measured phase shift angles and attenuation quantities are shown. (auth)

23898 LENGTH OF ELECTRON FREE PATH IN GAS DISCHARGE PLASMA FROM A LUMINESCENT TUBE. L. I. Turanova. Uch. Zap. Kaliningradsk. Gos. Ped. Inst., No. 10, 26-37(1962). (In Russian)

The effective cross section for elastic collision of electrons with atoms of a neutral gas (Ar and Hg) was calculated. The values were used to estimate the length of the electron free path, λ, in a gas discharge plasma from luminescent tubes. The method used was integration of the Drukarev equations (Zh. Eksperim. Teor. Fiz., 19(3): 247(1949)) with simplifying assumptions, which are valid in the electron velocity range observed. Calculated results are in good agreement with experimental curves. For typical luminescent tube operating conditions (P_{Ar} = 4 mm Hg, P_{Hg} = 0.01 mm Hg), λ = 3.64 cm. (TTT)

23899 CONFINEMENT OF HIGH-CONCENTRATION PLASMA IN ADIABATIC TRAPS. I. M. Podgornyi. Usp. Fiz. Nauk, 85: 65-86(Jan. 1965). (In Russian)

Recent achievements in the heating and confinement of high-concentration plasma (density $n \gtrsim 10^{11}$ cm^{-3}) in adiabatic traps are reviewed. Primary attention is given to works on the stability of confinement. Experiments performed in the Plasma Investigation Department of the Institute of Atomic Energy with a plasma concentration of 10^7 to 10^9 cm^{-3} show that with a 2×10^{-6} mm Hg vacuum in a simple adiabatic trap, the lifetime of the plasma is 100 μsec at a 5 kgauss intensity of the magnetic field. The trap was filled with plasma of 10^{10} cm^{-3} maximum concentration using an ion magnetron. Plasma lifetime increases monotonically with $a = \sqrt{H_\delta^2 + H_r^2}/H_0$, where H_0 is the intensity of the main field on the axis, and H_r is the field of rods in the lateral magnetic mirror. The experiments performed with the PR-5 installation showed a maximum lifetime of 10 to 15 msec. In these experiments the lifetime was limited by the charge exchange. Zavoyskiy investigated turbulent plasma heating, which is based on the collective friction of the electron flow through plasma. Collective friction occurs when the velocity of the ordered motion of the electron beam exceeds the average thermal energy of the plasma electrons. The investigation was conducted at concentrations of 2×10^{11} to 4×10^{13} cm^{-3}. The product of the plasma concentration on electron temperature remained unchanged in a wide range of initial concentrations ($nkT_e \approx 10^{15}$ ev/cm^3 when n varied from 2×10^{11} to 4×10^{13} cm^{-3}). The maximum value for average ion energy obtained from turbulent heating was 150–200 ev. Maximum temperature of the electrons was 5000 ev. At T_e = 500 ev and n = 10^{12} cm^{-3}, the experimentally determined lifetime was 60 μsec. The time of confinement of fast ions at T_e = 200 ev, T_i = 150 ev, and n = 10^{12} cm^{-3} was 130 μsec. Great technical difficulties associated with the generation of large amplitudes of the high-frequency magnetic field are encountered when attempts are made to use turbulent heating to obtain thermonuclear temperatures. (CFSTI)

23900 SOME ANALYTICAL SOLUTIONS FOR THE MOTION OF A THIN PLASMA RING IN A COAXIAL MAGNETIC FIELD. Chong-wei Chu. Z. Angew. Math. Mech., 44: 485-93(Oct.-Nov. 1964).

The motion of a thin plasma ring in a coaxial magnetic field is studied. Analytical solutions are obtained by applying standard techniques of handling non-linear differential equations; results and applications are discussed. (auth)

23901 QUANTITATIVE SPECTROSCOPIC INVESTIGATION OF RAPIDLY CONVERGING SHOCK WAVES IN HELIUM. Otto Ernst Berge and Woldemar Boetticher (Institut fur Experimentalphysik, Kiel). Z. Naturforsch., 19a: 1460-5(Dec. 15, 1964). (In German)

The time pattern of temperature and electron density behind the front of a converging cylindrical shock wave was calculated for various radii and compared with quantitative spectroscopic measurements. The temperatures were determined from the absolute intensity of optically thick helium lines and the electron density from the continuum intensity. A fast photoelectric eight-channel spectrometer with an accuracy of 10% was used for the measurement. The measured values agree with the values calculated on the basis of the model. (tr-auth)

23902 ERROR DISCUSSIONS FOR MAGNETIC PROBE MEASUREMENTS. W. Bez, W. Thielo, and W. Weber (Technische Hochschule, Stuttgart). Z. Naturforsch., 19a: 1466-74(Dec. 15, 1964). (In German)

The boundary error occurring in magnetic probe measurements in plasma was investigated on a model. In graphite rods of various diameter and given conductivity, perturbations in the form of drill holes of different dimension were introduced. The magnetic field measured with a magnetic probe in a condenser discharge was compared with the calculated unperturbed field pattern. The results show a strong dependence of the boundary error on the unperturbed radial current profile and on the transient current modifications limited by the skin effect. The approximation of the boundary error to the volume error, and therefore the possibility for the error estimation, are given only for large perturbation ratios (perturbation diameter/conductor diameter $\rightarrow$ 1). In the perturbation ratios $\ll$ 1 used in practice, the boundary error in each case is estimated to be larger than that from the perturbation volume. (tr-auth)

23903 ON THE APPROXIMATION METHOD FOR DETERMINATION OF SPECIFIC HEATS AND THE ISENTROPIC EXPONENTS OF A THERMAL PLASMA. J. Artmann (DVL-Institut fur Plasmadynamik, Stuttgart-Vaihigen, Ger.). Z. Physik, 183: 65-76(1965). (In German)

Neglecting radiation, excitation energies, lowering of ionization potentials and excluding the simultaneous existence of more than one ionization one can, in the case of equilibrium, find simple expressions for the specific heats and the isentropic exponent γ_s. The ratio of specific heats γ and the isentropic exponent γ_s are then related by a function, which only depends on the corresponding degree of ionization. The maximal difference between γ and γ_s decreases from 12.5 to 2.4% in the range from the first to the tenth ionization. Regarding the dissociation of a diatomic molecule with excited rotational and oscillation energy, but without excitation energies of electrons, it is shown that γ and γ_s are related by the same function, which is valid for the first ionization. For helium and argon, the calculated values only show (up to the fifth ionization) deviations of less than 5% from the known values. (auth)

23904 ANOMALOUS RESISTANCE AND MICROWAVE RADIATION FROM A PLASMA IN A STRONG ELECTRIC FIELD. B. A. Demidov, N. I. Elagin, D. D. Ryutov, and S. D. Fanchenko. Zh. Eksperim. i Teor. Fiz., 48: 454-63 (Feb. 1965). (In Russian)

The mechanism of the active resistance of a collisionless plasma observed in a toroidal arrangement with a strong electric field (100 v/cm) parallel to the quasistationary magnetic field is studied experimentally and theoretically. It is shown that the anomalous resistance is the result of excitation of intense Langmuir oscillations which carry the momentum out of the plasma. The theoretical estimate agrees satisfactorily with the experiments. An intense microwave radiation from the plasma is observed. It is shown that the observed microwave signal can be explained by assuming superposition of two effects, of emission of electromagnetic waves with a double plasma frequency from the plasma volume and excitation of surface waves. (auth)

23905 ON NONLINEAR INTERACTION OF WAVES IN A PLASMA. Yu. L. Klimontovich (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 488-98(Feb. 1965). (In Russian)

Nonlinear equations for slowly varying amplitudes and phases of the electric field strength are considered. An expression is obtained for the effective damping decrement in which change of the spectrum due to the dependence of the distribution functions on the slow coordinates and time are taken into account. It is shown that in the three, four, etc. wave approximation, the plasmon equation is replaced by an equation set which refers to a larger set of spectral functions, the number of which depends on the number of interacting waves. Stationary solutions of the spectral function equations are presented. (auth)

23906 ACCELERATION OF ELECTRONS IN A PLASMA IN A STRONG ELECTRIC FIELD. E. E. Lovetskii and A. A. Rukhadze (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 48: 514-25(Feb. 1965). (In Russian)

The behavior of a rarefied plasma in a strong uniform and stationary electric field is investigated. Linear approximation expressions are obtained for the time variation of small plasma disturbances. Conditions under which the initial disturbances (thermal noise) in the plasma do not practically increase with time are determined. Under these conditions unbounded acceleration of the plasma electrons occurs. The possibility of building a stable large-current gas betatron with a heavy gas is discussed. (auth)

23907 CHERENKOV RADIATION OF MAGNETOACOUSTIC WAVES FROM EXTENDED SOURCES. V. P. Dokuchaev (Gor'kii State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 48: 587-95(Feb. 1965). (In Russian)

Emission of magnetoacoustic waves by moving finite size sources is considered. Simple examples of such sources are a moving solenoid with a constant electric current and a volume mass source. The fields of the disturbances created by the solenoid are determined. Integral expressions are obtained for the radiation energy and wave resistance strength. It is shown that even in the absence of dispersion in the medium, the force and energy integrals converge due to interference of the Cherenkov radiation. The double crisis of the wave resistance of moving sources in a magnetic-active plasma is discussed. A kinematic explanation of the phenomenon is presented. (auth)

23908 ON SPACE DISPERSION OF INHOMOGENEOUS MEDIA. Yu. A. Ryzhov, V. V. Tamoikin, and V. I. Tatarskii (Gor'kii State Univ., USSR and Inst. of Atmosphere Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 48: 656-65(Feb. 1965). (In Russian)

The mechanism of space dispersion connected with random inhomogeneities in the medium is investigated. An expression is obtained for the effective dielectric permeability tensor of an inhomogeneous medium in the case of strong fluctuations of the dielectric permeability. It is shown that the presence of space dispersion due to nonuniformity of the medium does not result in the appearance of longitudinal waves of the mean field. As a concrete example an inhomogeneous plasma is considered. The extreme cases of weak and strong fluctuations of the dielectric permeability are investigated (at frequencies far or close to the plasma resonance frequency). (auth)

23909 EMISSION OF ELECTROMAGNETIC WAVES WITH A DOUBLE PLASMA FREQUENCY FROM A PLANE PLASMA LAYER. A. A. Ivanov and D. D. Ryutov. Zh. Eksperim. i Teor. Fiz., 48: 684-90(Feb. 1965). (In Russian)

Emission of electromagnetic waves with a double plasma frequency from a plane plasma layer is considered. A general expression is derived for the flux of electromagnetic radiation. It is shown that p-polarized waves are mainly emitted from a thin plasma layer (the layer thickness being small with respect to the length of the electromagnetic wave). A unit volume of a thin layer (defined as

above) emits per unit time considerably more energy than a unit volume of thick layer. (auth)

23910 PENETRATION OF AN ELECTROMAGNETIC WAVE INTO A PLASMA WHEN NONLINEARITY IS TAKEN INTO ACCOUNT. A. V. Gurevich (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim i Teor. Fiz., 48: 701-7(Feb. 1965). (In Russian)

The region of reflection of radio waves propagating in an inhomogeneous plasma is considered by taking into account the effect of the alternating electric field of the wave on the dielectric constant of the plasma. It is demonstrated that with increase of amplitude of the wave field the reflection point shifts into the plasma. The magnitude of this shift is calculated. The change in the critical frequency of transversal of the plasma by radio waves as a function of the amplitude of the wave field is determined. (auth)

23911 ELEMENTARY PLASMA PHYSICS. Lev A. Arzimovich. Translated by Scripta Technica, Inc. from Elementarnaya Fizika Plazmy. A Blaisdell Book in the Pure and Applied Sciences. New York, Blaisdell Publishing Co., 1965. 196p.

Basic phenomena of plasma physics are described. Discussions are given of the motion of charged particles in electric and magnetic fields and in plasma; electromagnetic radiation emitted by plasma; plasma electric current, diffusion, and thermal conductivity; experimental techniques—probe method, radio-wave measurements, spectrometry; plasma in a magnetic field; and applications to controlled thermonuclear reactions, MHD energy conversion, and plasma engines. (M.J.T.)

23912 INVESTIGATIONS INTO ELECTRICAL DISCHARGES IN GASES. B. N. Klyarfel'd, ed. A Pergamon Press Book. Translation by D. Cossutta of "Issledovaniya v Oblasti Elektricheskogo Razryada v Gasakh." New York, The Macmillan Company, 1964. 290p.

Papers (12) are included on investigations of processes occurring in electrical discharges in gases and vapors. The arc discharge in mercury vapor is emphasized, and the effect of mercury droplets on the mechanism of backfiring in mercury-arc rectifiers is studied. New methods for the measurement of vapor density in the vicinity of electric discharges and for determining the surface current density at an anode are described. (D.C.W.)

23913 AN EXPERIMENTAL AND THEORETICAL INVESTIGATION OF TURBULENCE INSTABILITIES AT PLASMA-MAGNETIC FIELD INTERFACES. Semi-Annual Report, October 1964. Winston H. Bostick (Stevens Inst. of Tech., Hoboken, N. J.). 21p. (CONF-641108-26)

From American Physical Society, New York.

The results of experiments on the turbulent behavior of plasma at interfaces in three different geometries are summarized, and a theoretical description of a plasma eddy or vortex is outlined. (D.C.W.)

23914 INTERACTION OF A LOW DENSITY PLASMA WITH HIGH-FREQUENCY ELECTROMAGNETIC FIELDS. M. P. H. Weenink (Stichting Voor Fundamenteel Onderzoek der Materie. Instituut Voor Plasma-Physics, Jutphaas, Netherlands). 9p. (CONF-641108-25)

From American Physical Society, New York.

An analysis of an experiment on plasma containment by high-frequency electromagnetic fields is outlined, treating only the one-dimensional case. Electron heating in nonadiabatic reflection by the h-f fields is considered, as well as adiabatic reflection. (D.C.W.)

23915 CYCLOTRON RESONANCE OF A CHARGED PARTICLE TO ONLY OSCILLATING ELECTROMAGNETIC FIELDS. James F. Holt. 7p. (CONF-641108-23)

From American Physical Society, New York.

The usual view of cyclotron resonance is broadened to include charged particles in an oscillating magnetic field with no steady component. An expression for the resonant frequency is given, and a system for plasma heating by a-c cyclotron resonance is outlined. (D.C.W.)

23916 EVIDENCE OF ANOMALOUS DIFFUSION IN AN RF DISCHARGE IN A MAGNETIC FIELD. E. J. Powers (Stanford Univ., Calif.). 18p. (CONF-641108-36)

From American Physical Society, New York.

Evidence of anomalous diffusion in a 29.3 Mc/sec r-f discharge immersed in a longitudinal magnetic field is described. The experimental study was made in argon and helium over a pressure range of 0.02 to 1.0 mm Hg. As in the investigations of anomalous diffusion in the d-c positive column carried out by Lehnert and others, the variation of voltage required to maintain a constant density discharge is used as a measure of the particle loss. In particular, it was found that as the magnetic field is increased from zero the r-f voltage and power required to maintain a constant density discharge initially decrease, but start to rise when the magnetic field exceeds a critical value B_c. This rise is accompanied by the onset of low-frequency fluctuations of a few tens of kilocycles. Further increases in magnetic field result in the growth of the amplitude of the fluctuations and in the introduction of higher frequency components into the spectrum. The critical field increases with increasing pressure p and decreasing tube radius R. Comparison of the r-f discharge critical magnetic field data with those obtained by Lehnert and others in d-c experiments, and Rugge and Pyle in a-c experiments is facilitated by plotting B_c/p vs pR. For a given gas, the r-f and d-c data lie on single but separate curves in the B_c/p, pR plane. In contrast to the a-c experiments, where application of kilocycle and tens of kilocycle currents result in higher B_c (as predicted by the Kademtsev and Nedespasev theory) than in the d-c experiments, application of 29.3 mC/sec currents result in the onset of instabilities at lower magnetic fields. (auth)

23917 RADIAL DENSITY DISTRIBUTIONS IN LORENTZ TRAPPING EXPERIMENTS. E. G. Murphy, A. C. Riviere, and D. R. Sweetman. 10p. (CONF-641108-18)

From American Physical Society, New York.

The radial density distribution resulting from Lorentz trapping of excited hydrogen atoms was investigated. Theoretical predictions were compared with measurements in the Phoenix 1A machine. (D.C.W.)

23918 EFFECTS OF A VELOCITY DEPENDENT COLLISION FREQUENCY ON WAVE-PLASMA INTERACTIONS. R. F. Whitmer and G. F. Herrmann (Lockheed Missiles and Space Co., Palo Alto, Calif.). 31p. (CONF-641016-2)

From 17th Annual Gaseous Electronics Conference, Atlantic City.

It is shown that the characteristics of a wave propagating in an ionized gas, whose collision frequency is velocity dependent, can be described by two parameters. These two parameters, an effective collision frequency and an effective plasma frequency, are functions of the form of the velocity dependence of the collision frequency, the ratio of the frequency of the wave to the gas pressure, and the electron distribution function. This formulation provides direct physical insight into the effects of the velocity dependence of the collision frequency on wave-plasma interactions. At the same time, this technique allows the use of the many tables and curves presently in use which describe the wave characteristics in terms of constant collision and plasma frequencies. The introduction of effective parameters furthermore provides a characterization of a plasma which makes it possible to predict many of the qualitative features of wave propagation without requiring much prior knowledge of the detailed functional form of $\nu_m(w)$. In the case of a magneto-plasma the effective parameters allow one to predict the effect of the velocity dependence of ν_m on the electron cyclotron resonance line shape. It is shown that the variation of ν_m produces a line which is more peaked than the Lorentzian line, which is obtained for ν_m constant. Details of the line shift and the line shape are also explained. Specific examples are given for neon, helium, argon, and nitrogen. (auth)

23919 A METHOD FOR MEASURING THE PLASMA POTENTIAL AT GLASS WALLS. H. Heil and R. A. Blanken (Hughes Research Labs., Malibu, Calif.). 6p. (CONF-641016-4)

From 17th Annual Gaseous Electronics Conference, Atlantic City.

A method for potential measurements is described, in which the potential assumed by a conductor on the outside of the glass wall is measured. The electric field in the positive column of laser-type discharges was measured as a function of the discharge parameters, using conducting rings around the glass tube. At the lower pressures, the electric field was sensitively affected by variations in the shape of the envelope. A Langmuir probe had little effect on the electric field. Hall-effect measurements were also made, which indicate a surprisingly large electron drift energy. (D.C.W.)

23920 TEMPERATURE RELAXATION IN A FULLY IONIZED PLASMA. C.-S. Wu, E. H. Klevans, and J. R. Primack (California Inst. of Tech., Pasadena). 25p. (CONF-641108-37)

From American Physical Society, New York.

The times for relaxation of anisotropic ion or electron temperatures to isotropy, and for relaxation of different ion and electron temperatures to equilibrium, are calculated using the plasma kinetic equation including dynamic shielding. It is shown that, in contradiction to the results (or assumptions) of previous analyses, electron-ion interactions can be more important than interactions between particles of the same species in the relaxation of an anisotropic distribution. The meaning of relaxation time is discussed, and a new time for relaxation is introduced for the problem of the relaxation of electron and ion temperatures that are initially greatly different. Detailed numerical computations are presented for various cases of special interest. (auth)

23921 CROSS SECTION AND ANGULAR VARIATION OF RF RADIATION SCATTERED FROM A POSITIVE COLUMN. J. E. Butterworth and R. L. Moore (Douglas Aircraft Co., Inc., Long Beach, Calif.). 89p. (CONF-641108-33)

From American Physical Society, New York.

Through the use of improved equipment and techniques of measurement in a r-f scattering facility, the angular distribution of the scattered radiation from a positive column was measured and was found to be dipole below, at, and above the main resonant frequency. Using silvered rods for calibration, the cross section at resonance, at 4 Bc for a column with an inside diameter of 5.5 mm was found to be 36 times the cross section for a perfectly conducting rod of the same diameter. Above the resonant frequency, the back-scattering cross section is less than that of a silver rod, but greater than that calculated by using an "underdense" model. Below the resonant frequency, the back-scattering cross section is slightly greater than that of a silver rod. However, while the diffraction pattern of the rod is of the form $A + B \cos \theta$, the pattern for the "overdense" column is of the form $\cos \theta$. (auth)

23922 GAS BREAKDOWN BY OPTICAL FREQUENCY RADIATION. A. F. Haught and R. G. Meyerand, Jr. (United Aircraft Corp., East Hartford, Conn.). 11p. (CONF-641016-5)

From 17th Annual Gaseous Electronics Conference, Atlantic City.

The electrical breakdown of gases by optical frequency radiation was studied over a wide range of pressures in a number of gases. Field strengths of the order of 10^7 volts per cm from a 25-nsec ruby laser pulse were required for the breakdown and resulted in electron densities up to 10^{19} electrons per cm^3 within the breakdown volume. Diagnostics involving charge collection, spectroscopy, and framing camera photographs of the breakdown luminosity were used to study the phenomena. Measurements of the attenuation of the irradiating laser beam show that the breakdown developed within 5 to 9 nsec of the start of the optical pulse. It was established that the energy removed from the irradiating beam is absorbed by the breakdown plasma. The rapid development of the breakdown cannot be adequately explained on the basis of existing theories of breakdown in gases. This production of a plasma by optical frequency radiation provides a unique method for the study of high-density plasmas without requiring the use of electrodes or otherwise introducing possible contaminants to the plasma. (auth)

23923 PLASMA PRODUCTION BY LASER BEAM IRRADIATION OF SOLID PARTICLES. A. F. Haught and R. G. Meyerand, Jr. (United Aircraft Corp., East Hartford, Conn.). 8p. (CONF-641108-39)

From American Physical Society, New York.

The focused beam of a Q-spoiled ruby laser was used to vaporize, excite, and ionize a solid particle suspended in a vacuum by an a-c electric field. The giant pulse output of the laser used in these experiments has a triangular waveform with a pulse halfwidth of 20 nsec and a peak power up to 30 Mw. The 10 to 100 micron diameter solid particle is charged by an electron gun and suspended in a vacuum in the electric field produced by a cubical array of electrodes, opposite pairs of which are connected to a three-phase a-c supply. The suspended particle is irradiated by the laser beam resulting in the production of a high-density, high-temperature plasma. The number of atoms receiving the laser beam energy is determined by the solid particle mass; and, since the breakdown is produced in a vacuum environment, no collisional cooling of the resulting plasma occurs. Studies of such particle breakdown plasmas are reported, including charge production, high-speed photographs, and spectrographic diagnostics. (auth)

23924 ION-ELECTRON ENERGY DISTRIBUTIONS IN THE MODEL C STELLARATOR. Harold P. Eubank. 9p. (CONF-641108-41)

From American Physical Society, New York.

A multiple-grid electrostatic energy analyzer was used to determine the charged-particle energy distributions in the diverted plasma of the Stellarator (c). The distributions in both helium and hydrogen plasmas were observed. It was concluded that in normal Stellarator(c) discharges the electron distributions are Maxwellian out to at least 5k Te and that a sheath of voltage ~3kTe/e exists, which accelerates ions into the wall. (D.C.W.)

23925 CHEMICAL USES OF INDUCTION PLASMAS. T. B. Reed (Massachusetts Inst. of Tech., Lexington). 16p. (CONF-641201-15)

From American Institute of Chemical Engineers Annual Meeting, Boston.

The techniques for production of induction plasmas are outlined and the properties of induction plasmas are compared to electrode plasmas. Induction plasmas are operable in a greater variety of atmospheres, have lower velocities and longer dwell times, and are especially amenable to the injection of solids and gases. A number of applications for gas-solid reactions are discussed. Use of induction plasmas for exploratory high-temperature, gas-phase chemistry and the search for new molecules is recommended. (auth)

23926 USE OF INTERFEROMETRIC SPECTROSCOPY FOR FAR INFRARED PLASMA DIAGNOSTICS. D. T. Llewellyn-Jones (Massachusetts Inst. of Tech., Cambridge). 9p. (CONF-641108-34)

From American Physical Society, New York.

The use of infrared interferometric spectroscopy to study the dielectric properties of plasmas is analyzed. (D.C.W.)

23927 QUASI-LINEAR THEORY FOR SMALL LARMOR RADIUS UNIVERSAL INSTABILITIES. F. C. Hoh (Univ. of California, San Diego, La Jolla). 48p. (CONF-641108)

From American Physical Society, New York.

A class of universal instabilities is reviewed. The basic physical mechanism of these instabilities is illustrated with a simple physical picture, and the large amount of energy available to drive these instabilities is pointed out. A small Larmor radius quasi-linear theory is developed for a class of unstable ion waves whose phase velocities along the magnetic field lie between the thermal velocities of ions and electrons. In the approximation of localized perturbations, the final-state quantities of the plasma are given without specifying the detailed instability mechanism. An essential feature is that the quasi-linear theory predicts an anoma-

lous "displacement" of a group of resonant particles rather than any anomalous diffusion. The theory is applied to a special type of the current-driven universal instability. Its quasi-linear consequences is explored. (auth)

23928 RADIATION AT THE PLASMA FREQUENCY AND ITS HARMONIC FROM A TURBULENT PLASMA. P. A. Sturrock, R. H. Ball, and D. E. Baldwin (Stanford Univ., Calif.). 25p. (CONF-471-56)

From American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963.

Any mechanism which couples electrostatic waves (plasma oscillations) and electromagnetic waves in a plasma will lead to radiation from plasma oscillations. The most important consequence of nonlinearity of the equations is that two electrostatic waves are coupled to one electromagnetic wave; this process is therefore responsible for radiation at the second harmonic ($2\omega_p$). Low-frequency or static inhomogeneities of the plasma couple one electrostatic wave to one electromagnetic wave and therefore produce radiation at (or near) the plasma frequency. Two types of inhomogeneity are considered: "isotropic" inhomogeneities, which are fluctuations in the plasma density, and "anisotropic inhomogeneities," which comprise an inhomogeneous distribution of currents and magnetic fields. (auth)

23929 INVESTIGATIONS OF GROWING WAVES EXCITED IN A PLASMA BY AN ELECTRON STREAM. John R. Apel and Albert M. Stone (Johns Hopkins Univ., Silver Spring, Md.). 21p. (CONF-641108-40)

From American Physical Society, New York.

An experiment was conducted to study waves excited in a plasma by an electron stream. A PIG source generates a hydrogen plasma of density up to $10^{13}/cm^3$ and 30-ev electron temperature, confined by a 500-gauss field. A 40-mamp, 1000-v electron beam is pulsed into the plasma. Coherent, growing waves are excited at frequencies typically near 500 mc when the plasma frequency is 1800 mc and the cyclotron frequency is 900 mc. The wave grows in both space and time until reaching a limiting amplitude, after which it decays; this entire process repeats at about a 40-mc repetition rate at a power level of several watts. Diagnostic equipment includes a 3000-mc oscilloscope, a spectrum analyzer, and various probes. If the dispersion equation governing the waves is solved for the finite geometry of the experiment, it becomes apparent that the growth occurs because of the interaction between the slow plasma wave on the electron beam and the electron cyclotron wave in the plasma. (auth)

23930 A NOTE ON QUASI-PHOTONS IN A PLASMA. Willard R. Chappel (Univ. of Colorado, Boulder), Wesley E. Brittin, and Solomon J. Glass. 6p. (CONF-640606-14)

From American Physical Society Summer Meeting, Denver.

It is pointed out that the Bogoliubov transformation used to transform the bare transverse photon destruction (creation) operators into quasi-photon operators provides a rigorous and useful basis for treating plasma equilibrium and transport problems. The transformation diagonalizes part of the total hamiltonian, and the hamiltonian is obtained as the sum of three terms: the particle part, the free quasi-photon part, and the quasi-photon interaction part. An example is given of the use of the quasi-photon picture in the equilibrium problem for noninteracting quasi-photons. (L.B.S.)

23931 DIAGNOSTICS OF A HOT, LAMINAR FLOW, ARGON PLASMA JET IN AIR. Ray Hefferlin, Bill Mundy, and Marilyn Crooker (Southern Missionary Coll., Collegedale, Tenn.). 18p. (CONF-641114-1)

From American Physical Society, Southeastern Section, Chattanooga.

A comprehensive diagnostic study of a hot, laminar flow, argon plasma jet exhausted into the atmosphere is described. It is assumed that local thermodynamic equilibrium equations could be used in the diagnostic procedures, and that the impurities were present in sufficiently small amounts that Saha's equation could be applied to the argon exclusively. It is shown that hydrogen was present in larger amounts than the other impurities, and that the hydrogen could be ignored compared to the argon. A calculation from Saha's equation of the electron density from the temperature obtained by relative line intensities or the Fowler-Milne method was used as a check on the electron density by the hydrogen line profiles. (L.B.S.)

23932 THE FLOW OF A COLLISIONLESS PLASMA OVER A CONE. S. H. Lam and M. Greenblatt (Princeton Univ., N. J.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-125, 21p, $1.00. (CONF-650108-2)

From AIAA 2nd Aerospace Sciences Meeting, New York.

In a flowing low density plasma, the presence of a solid body introduces electrostatic as well as gasdynamic disturbances. Recently Lam and Greenblatt presented a general theory for these electrogasdynamic problems under the assumptions that the ion thermal velocity is negligible compared to the flow velocity and that the characteristic length of the problem of interest is much greater than the Debye length. The flow of a collisionless plasma over a right circular cone is considered within the framework of this general theory. By confining attention to the case when the flow velocity is greater than the ion wave speed (the supersonic case), the conical, self-similar solutions are constructed and presented for a large range of flow velocities and cone angles. The ion saturation current density on the cone surface and the potential at the edge of the sheath are computed. Limiting behaviors of the solutions near various singular points in the governing equation are analyzed and discussed. (auth)

23933 INVESTIGATIONS OF GROWING WAVES EXCITED IN A PLASMA BY AN ELECTRON STREAM. John R. Apel and Albert M. Stone (Johns Hopkins Univ., Silver Spring, Md.). New York, American Inst. of Aeronautics and Astronautics, 1965, Preprint Paper No. 65-93, 12p, $1.00. (CONF-650108-9)

From AIAA 2nd Aerospace Sciences Meeting, New York.

An experiment was performed to study waves excited in a plasma by an electron stream. A PIG source generates a hydrogen plasma of density up to $10^{13}/cm^3$ and 30 ev electron temperature, confined by a 500 gauss field. A 40 ma, 1000 volt electron beam is pulsed into the plasma. Coherent, growing waves are excited at frequencies typically near 500 mC when the plasma frequency is 1800 mC and the cyclotron frequency 900 mC. The wave grows in both space and time until reaching a limiting amplitude, after which it decays; this entire process repeats at about a 40 mC repetition rate at a power level of several watts. Diagnostic equipment includes a 3000 mC oscilloscope, a spectrum analyzer, and various probes. If the dispersion equation governing the waves is solved for the finite geometry of the experiment, it becomes apparent that the growth occurs because of the interaction between the slow plasma wave on the electron beam and the electron cyclotron wave in the plasma. (auth)

23934 A HYDROMAGNETIC WAVE IN AN INHOMOGENEOUS, CYLINDRICAL PLASMA. C. K. McLane and T. Tsukishima (National Bureau of Standards, Washington, D. C.). 28p. (CONF-641108-29)

From American Physical Society, New York.

A transverse, comparatively low frequency standing wave was identified on the plasma column of a magnetically confined argon arc. The frequency of this wave, under some conditions, obeys a dispersion relation given by Weinstock for a generalized hydromagnetic wave in an inhomogeneous, rotating plasma. The wave frequency, which may be higher than the ion gyrofrequency, is closely coupled with the fluid rotation velocity of the plasma. When the differences between these passes the ion gyrofrequency, transition to another, as yet unidentified, mode takes place. (auth)

23935 RADIATION FROM A FULLY IONIZED GAS AT THE PLASMA FREQUENCY. E. C. Taylor (Aerospace Corp., El Segundo, Calif.). 25p. (CONF-641108-27)

From American Physical Society, New York.

Thermal radiation from a fully ionized gas near the

plasma frequency is investigated theoretically with consideration of boundary effects. It is shown that the emission spectrum is a relatively complicated function of frequency, temperature, density, and geometry, but that the absorption spectrum can be approximated by a simple function of the three parameters representing frequency, collisions, and geometry. The sensitivity of the absorption curve to these parameters is investigated, and the results are used to interpret recently measured infrared radiation from a theta pinch. (auth)

23936 ANOMALOUS COLLISIONLESS DAMPING OF ALFVEN WAVES IN INHOMOGENEOUS MAGNETIC FIELDS. F. Winterberg (Univ. of Nevada, Reno). 49p. (CONF-641108-24)

From American Physical Society, New York.

It is shown that Alfven waves in a collisionless plasma, permeated by an inhomogeneous magnetic field, are affected by a strong anomalous damping. This anomalous collisionless damping seems to correspond to collision-free Landau damping in homogeneous magnetic fields in a similar way as the anomalous viscous and ohmic damping of Alfven waves propagating in inhomogeneous magnetic fields corresponds to the ordinary collisional viscous and ohmic dissipation of Alfven waves propagating in homogeneous magnetic fields. It is found that the predicted collision-free anomalous damping will obey a law of the form $e^{-(t/\tau)^2}$, where the dissipation time τ depends on the wave-length, the temperature of the plasma, and the magnetic field gradient. Starting from a simplified Boltzmann-Vlasov equation, valid for low frequency plasma waves, a Laplace transform is carried out with regard to the time dependence and an integral equation is derived for the mean plasma velocity. By the faulting theorem this integral equation can be Fourier transformed into a differential equation for which a WKB solution can be obtained. The back transforms can be carried out by making a simple analytic approximation to the WKB solution which is valid over a large range of values. The predicted anomalous damping of Alfven waves is so strong that it may be useful for the purpose of heating a plasma up to very high temperatures within a short time. (auth)

23937 METHOD AND APPARATUS FOR GENERATION OF PLASMA WITH DIRECTED TRANSLATIONAL ENERGY. Siegfried Hansen (to Litton Industries, Inc.). German Patent 1,184,429. Dec. 31, 1964. Filed Feb. 10, 1961.

A toroidal plasmoid is generated and accelerated as such by a magnetic piston produced by a traveling wave. Since the lines of magnetic force extend through the center of the plasmoid diffusion of the ionized gas away from the central axis of the magnetic piston is avoided. The apparatus for carrying out this method comprises an elongated, conical, and evacuated vessel wound with a solenoid, and a plasma source arranged at one end of the vessel. The plasma source communicates with the accelerating volume through an annular slit. (Gmelin Inst.)

23938 SUPERCONDUCTOR SOLENOID WITH OVERHEAT PROTECTIVE STRUCTURE AND CIRCUITRY. R. G. Mills and K. E. Wakefield (to U. S. Atomic Energy Commission). U. S. Patent 3,177,408. Apr. 6, 1965.

A superconductor solenoid was developed for producing high-strength magnetic fields in which large amounts of energy are stored. Means are provided for producing magnetic fields along the axis of the solenoid greater than the critical field of the superconductor adjacent its surface. The field is collapsed, to transfer the energy therein to a load, and provision is made for preventing damage to the superconductor when the field is collapsed due to accident or by design. This apparatus may also be used to produce a high-strength magnetic field for confining a high temperature plasma. (AEC)

Shielding

Refer also to abstracts 21992 and 22823.

23939 (NP-14882) FAST NEUTRON STREAMING THROUGH TWO-LEGGED CONCRETE DUCTS. Technical Report R-354. T. Y. Song (Naval Civil Engineering Lab., Port Hueneme, Calif.). Feb. 2, 1965. 52p.

As a part of fundamental shielding studies for personnel shelters, fast-neutron dose rates are calculated in the second leg of an air duct through concrete for neutron energies of 14 and 2.5 Mev. The calculational technique is based on the albedo concept. Dose rates are also calculated by a Monte Carlo technique, and the results obtained by the two theoretical methods are compared with each other and with experimental measurements. Comparison shows agreement among these three independent determinations. (auth)

23940 (UCRL-11810) SHIELDING DOORS. Lee R. Glasgow and James M. Haughian (Lawrence Radiation Lab., Univ. of California, Berkeley). Mar. 2, 1965. Contract W-7405-eng-48. 6p. (CONF-650306-42). Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

From Particle Accelerator Conference, Washington, D. C.

General types of shielding doors and the drive systems for opening and closing them are described. Estimated costs of the different types of doors based on factors they have in common are compared, and a number of shielding doors designed and built at Lawrence Radiation Laboratory are described. These include a vertically rising door actuated by a hydraulic cylinder in a pit beneath it, a rotating slotted-barrel door, a swinging door, and a number of more or less typical sliding doors. Some of the problems involved in the design and use of these doors are discussed. Actual costs for a number of doors are given. (auth)

23941 THE PROPERTIES OF LEAD-OXIDE AND RARE-EARTH MATERIALS FOR NUCLEAR TECHNOLOGY. H. Schumann (Universitat, Marburg, Ger.). Ber. Deut. Keram. Ges., 42: 39-43(Feb. 1965). (In German)

If sintered with rare earth oxides, PbO and $PbSiO_3$ form ceramic materials of high density and high cross section for trapping thermal neutrons. The investigation covered various mixing ratios of the lead components and samarium oxides, rare earth oxide mixtures, natural monazite sand, and gadolinite. (auth)

23942 INVESTIGATION OF CASCADE SHOWERS IN LEAD WITH X-RAY FILMS. Yojiro Murata (Tokyo Univ.). J. Phys. Soc. Japan, 20: 209-21(Feb. 1965).

By using x-ray films with different sensitivities, observations were made on the lateral and longitudinal distributions of the energy loss in showers developing in lead. The x-ray films inserted among lead plates were irradiated by an electron beam with an energy of 200 Mev and by a bremsstrahlung gamma-ray beam with peak energies of 720 and 200 Mev. There seems to be some difference between the present results and those of Kantz and Hofstadter in the lateral and longitudinal distributions of the energy loss in the electron-initiated shower. This difference is discussed in some detail. The results are also compared with conventional shower theory. The fractional energy loss contained in various cylindrical volumes of lead is calculated from data obtained in the present experiment to facilitate a determination of the efficiency of a total absorption type detector. (auth)

23943 CALCULATION OF IRRADIATED-FUEL SHIELDING. F. Rohloff (Kernforschungsanlage, Julich, Ger.). Kerntechnik, 7: 105-8(Mar. 1965). (In German)

The energy spectrum of spent fuel is a function of reactor operating and cooling time. Shielding calculations become troublesome when using the full fuel spectra, or may include errors due to gross simplifications. To avoid both, a machine program was compiled, which makes use of all available data on energy spectra, cross sections, and buildup factors. The program calculates dose rates behind multilayered shielding as a function of reactor operating and cooling time, and for variable reactor power. (auth)

23944 SHIELDING REQUIREMENTS FOR MANNED ORBITING SPACE STATIONS. T. M. Jordan, E. F. Koprowski, and R. W. Langley (Douglas Aircraft Co., Inc., [Santa Monica, Calif.]). 29p. (CONF-720-25)

From 2nd Symposium on Protection against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

A detailed parametric investigation of radiation shielding requirements was performed for first generation manned orbiting space stations. Two specific space station designs were studied; the results of the shielding analysis are based on the actual geometry of the vehicles, onboard equipment, and supplies. Results are presented for circular orbits ranging from 100 to 600 nautical miles and from 29 to 90° inclination. The effects of the geometry of the space stations, the use of personal shielding, and the use of particular shielding materials are discussed. (auth)

23945 THE APPLICATION OF THE LIOUVILLE THEOREM TO MAGNETIC SHIELDING PROBLEMS. A. D. Prescott, E. W. Urban, and R. D. Shelton (Marshall Space Flight Center, Huntsville, Ala.). 24p. (CONF-720-12)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Shielding by magnetic fields is discussed using a theoretical treatment of charged-particle motion in electromagnetic fields. The problem of specifying the flux of unbound particles at a point in an axially symmetric magnetic field, assuming an isotropic, homogeneous distribution at infinity, is considered. It is shown that the flux can be calculated in each shielded and partially shielded region defined by a critical point, provided the critical point can be found. The technique of finding the critical points in infinitesimal multipole fields and in the fields of two finite parallel current loops is demonstrated, and the complex behavior of the saddle points in the double current loop system is demonstrated. Examples are given for various multipole fields, and the role of the partially shielded regions in the application of magnetic fields for space-vehicle shielding is emphasized. (M.J.T.)

23946 SOLAR FLARE HAZARD TO EARTH ORBITING VEHICLES. E. Kuhn, F. E. Schwamb, and W. T. Payne (Republic Aviation Corp., Farmingdale, N. Y.). 14p. (CONF-720-26).

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

Procedures are developed for calculating approach cones for solar flare particles at points on the orbit of an earth satellite, taking into account the effects of the geomagnetic field and also the magnetic effects of the solar flare. The purpose is to provide information for optimum shielding design for satellites. Three models are considered for the geomagnetic field: (1) a pure dipole field, treated by simple Störmer theory, (2) a dipole field with a superposed time-dependent uniform field to simulate the effects of the magnetic storm, treated by a modified Störmer theory, and (3) same as Model (2) but with shadowing effects of the earth considered in an approximate way. Computer programs were constructed for the first two of these models. (auth)

23947 ERRORS FROM GEOMETRIC APPROXIMATIONS INTRODUCED IN THREE COMPUTATIONAL MODELS FOR SPACE VEHICLE ELECTRON DOSE PREDICTION. R. P. Moshofsky (Boeing Co., Seattle). 23p. (CONF-720-27)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

The evaluation of shield designs for space vehicles is a complex problem involving the coupling of radiation transport to difficult geometries. Various approximations are made regarding both geometry and physical interactions in order to shorten computation time. It is desirable to know the significances of error introduced by geometric approximations. Using the idea that simplified models should be most nearly valid for simple geometries, three models for electron dose calculation are compared in cases involving spherical shell shields. The explicit differences in these models relate mainly to the treatment of the radiation angular distributions and the shield geometry. Relatively accurate calculations are possible for spherical shell cases so that error estimates are made for the various computational procedures. (auth)

23948 MONTE CARLO CALCULATIONS AND EXPERIMENTAL DATA FOR RADIATION STREAMING THROUGH BENT DUCTS. J. D. Marshall (General Dynamics, Fort Worth, Tex.). 14p. (CONF-654-46)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

A duct-streaming experiment was performed to provide data for a parametric study and for verification of the Monte Carlo Multibend-Duct Procedure (LO5). No general tendencies of the integrated dose rates could be ascertained for the duct parameters considered. Comparisons of calculated and experimental data indicate the validity of the calculational procedure. (auth)

23949 A GAMMA RAY PROBE SYSTEM FOR DETERMINING THE SHIELDING EFFECTIVENESS OF THE APOLLO VEHICLE. A. D. Krumbein, R. C. Ross, and C. Beaulieu (United Nuclear Corp., White Plains, N. Y.). 15p. (CONF-720-21)

From 2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn., Oct. 1964.

A gamma probe technique to determine the shielding effectiveness of any given material configuration against proton radiations likely to be encountered in space, was devised and tested. The essence of the technique is the use of gamma attenuation measurements to determine the areal electron densities along a great many paths through the configurations to be tested. A computer code is then used to calculate the proton dose received behind these configurations from typical space proton spectra. The basis of the gamma probe technique is reviewed, and a semiautomatic system designed to determine the shielding effectiveness of the Apollo Command and Service Modules is described. This system is capable of obtaining data at as many as 10 dose points inside the module simultaneously. Additional applications of the gamma probe technique are mentioned. (auth)

23950 THE EXTERNAL BREMSSTRAHLUNG PRODUCED IN THIN FOILS BY Pm^{147}. Vincent C. Truscello (Martin Marietta Corp., Baltimore) and Joseph Silverman. 8p. (CONF-641017-3)

From Symposium on Low Energy X and Gamma Sources and Applications, Chicago.

A NaI(Tl) scintillation spectrometer was used in conjunction with a 512-channel analyzer to study the spectral distribution of the external bremsstrahlung produced by ^{147}Pm betas (E_{max} = 223 kev) in thin foil targets ranging in thickness from 1 to 70 mg/cm^2 and in atomic number from 13 to 73. The bremsstrahlung was found to have a linear dependence on the atomic number of the target material as predicted by theory. Empirical relations among the experimental data were determined. (auth)

23951 ELECTRON SHIELDING FOR SPACE VEHICLES. B. W. Mar (Boeing Co., Seattle). 14p. (CONF-654-47)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

A nomograph constructed from a relation for the number density, which permits evaluation of the differential energy spectra penetrating a slab, is presented. The relations can be used to generate dose transmission data for any incident electron spectra. The electron shielding of a space vehicle exposed to geomagnetically trapped radiation can be designed using the transmission data and a geometric analysis of the vehicle. (L.B.S.)

23952 DEVICE FOR RADIATION SHIELDING OF DUCTS THROUGH SHIELDING WALLS. Wilhelm Lehner (to Gesellschaft fur Linde's Eismaschinen). German Patent 1,184,026. Dec. 23, 1964. Filed Jan. 4, 1962.

The diameter of the duct is enlarged within the shielding wall and the enlarged portion is filled with a radiation-absorbing fill. (Gmelin Inst.)

Solid State Physics

See also CHEMISTRY — Inorganic and Physical Chemistry
METALS, CERAMICS, AND OTHER MATERIALS — Properties and Structure

Refer also to abstracts 22157, 22160, 22283, 23056, 23275, 23421, 23507, 23623, and 23869.

23953 (AD-606407) ENERGY OF ELECTRONS EXTRACTED FROM SOLIDS BY HIGH ELECTRIC FIELDS. Final Report, June 1959–September 1964. Allan M. Russell (California Univ., Riverside. Dept. of Physics). Contract Nonr-1842(02). 33p. $2.00(CFSTI).

Research on the following aspects of field emission spectroscopy is summarized; resolution and electron optics; phase sensitive detection; field emission spectra of silicon; spectrometers; optical properties of field-emission cathodes; and measurements on photo-stimulated emission. (auth)

23954 (JINR-P-2002) ISSLEDOVANIE p-n PEREKHODA V KREMNII S POMOSHCH'YU ZHIDKIKH ELEKTROFOTOGRAFICHESKIKH PROYAVITELEI. (Investigation of the p-n Transition in Silicon by Means of Liquid Electromagnetic Developer). A. S. Antonov and L. G. Yuskeselieva (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1965. 9p. Dep. (mn).

The p-n transition in Si is studied by means of liquid electrophotographic developer. The concentration of the acceptors in the p-type silicon is determined. The results are similar to those obtained from the specific resistance and from measurements of the capacity of the p-n transition. (auth)

23955 (LA-3198) AN INTEGRATED SERIES OF CRYSTALLOGRAPHIC COMPUTER PROGRAMS. IV. FOURIER SERIES ANALYSIS. R. B. Roof, Jr., Don T. Cromer, and Allen C. Larson (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Aug. 1964. Contract W-7405-eng-36. 81p. Dep.; $3.00(cy), 2(mn) CFSTI.

The procedures employed and the computer programs used for a Fourier series analysis of x-ray intensity data are described. The programs compute Patterson vector maps and electron density maps of the Fourier and difference Fourier types. The programs may also be combined with a plotting program for the General Dynamics SC4020 High Speed Microfilm Recorder to obtain the maps drawn on 35-mm film. (auth)

23956 THE INTERFEROMETRIC MEASUREMENT OF THERMAL EXPANSION: THE THERMAL EXPANSION OF CAESIUM IODIDE AT LOW TEMPERATURES. B. W. James and B. Yates. Cryogenics, 5: 68-72(Apr. 1965).

The linear thermal expansion of a cesium iodide single crystal has been measured by the interferometric method, employing photographic recording, in the temperature range 20 to 270°K, with an absolute accuracy of 2 per cent. Difficulties were encountered in the use of triads of specimens, and the account contains a description of the method by which these were overcome. Experimental results for copper, obtained for comparison with other data, and the experimental results for cesium iodide are plotted. Smoothed values of the linear expansion coefficient α and the Grüneisen parameter γ are tabulated for cesium iodide. γ was calculated from α and recent experimental elasticity and specific heat data. This is independent of temperature down to 40°K or lower, suggesting a value of $n > 15$ in the model incorporating the Coulomb potential between the ions and a nearest neighbor interaction varying as r^{-n} in cesium chloride structures. (auth)

23957 INFRA-RED SPECTRA OF SOME ALKALI METAL URANATES. H. R. Hoekstra (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 27: 801-8(Apr. 1965).

Infrared spectra (900-240 cm^{-1}) of twelve alkali metal uranates are presented. Uranyl stretching vibrations of the monouranates occur between 700 and 800 cm^{-1}, and of the diuranates between 750 and 850 cm^{-1}. The infrared results are correlated with x-ray diffraction data, and uranyl bond lengths of the compounds were calculated. (auth)

23958 GROUPING OF PINNING POINTS ON DISLOCATION LINES. Georg Alefeld (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phil. Mag. (8), 11: 809-26(Apr. 1965).

Mobile pinning points on or near dislocation lines tend to group together. The driving force is the entropy of the dislocation lines. External oscillating stresses, which exceed a certain critical amplitude, increase this grouping tendency. These phenomena are first considered in detail for the model of one mobile pinner between two immobile ones. Equations for the equilibrium distributions without and with external stress and for the entropy force are derived. A partly quantitative partly qualitative extension to many pinners on the line is given. Consequences for the distribution of pinning points, created by radiation damage, quenching or cold work, and for the interpretation of internal friction and modulus defect measurements are discussed. It is suggested that external oscillating stresses be used to enhance the precipitation of point defects, such as vacancies, interstitials, or impurities, on dislocation lines. (auth)

23959 ON THE MAGNETIC AND CHEMICAL PROPERTIES OF EUROPIUM FLUORIDE. K. Lee (Varian Associates, Palo Alto, Calif.) H. Muir, and E. Catalano. Phys. Chem. Solids, 26: 523-8(Mar. 1965).

Electron spin resonance, chemical and x-ray studies were performed on several different, nominally EuF_2, single crystal samples. EuF_2 has been reported to be apparently antiferromagnetic. This study showed the various samples to be paramagnetic down to 1.6°K. In some samples, however, magnetically ordered inclusions were observed in the paramagnetic host. Electron spin resonance at x-band frequencies indicated a transition at $T_N = 19.5$°K. An observed unaxial anisotropy and a direct dependence of the resonance field with frequency is compatible with the high frequency mode of an antiferromagnet. The most intense antiferromagnetic resonances were observed in samples which contained $\sim 10^{-5}$ mole ratio of the inclusions (average size $\sim 0.5 \times 20.0 \times 20.0$ μ). Assuming an ordering of the second kind an exchange field $H_E = 4.84 \times 10^4$ gauss is calculated. The ⟨110⟩ directions of the host lattice appear to be the easy directions. For $T \ll T_N$, $(2H_E H_A)^{1/2} = 2510$ gauss is observed. The magnetically ordered inclusions are apparently an oxyfluoride. The single-crystal samples varied in stoichiometry between $EuF_{1.82}$ to $EuF_{2.39}$ with the lattice constant varying respectively from 5.838 to 5.798 Å. Details of the sample preparations are given. (auth)

23960 MAGNETIC PROPERTIES OF ORDERING HEAVY RARE-EARTH ARSENIDES. G. Busch (Eidgenossische Technische Hochschule, Zurich), O. Vogt, and F. Hulliger. Phys. Letters, 15: 301-3(Apr. 15, 1965).

The magnetic susceptibility of the rocksalt-type arsenides GdAs, TbAs, DyAs, HoAs, and ErAs was measured between 2 and 300°K. In the paramagnetic temperature range the susceptibilities of all these arsenides follow a Curie-Weiss law. The paramagnetic Curie temperatures, effective magneton numbers, Néel temperatures, exchange energies between nearest and next nearest neighbors, magneton numbers, and critical fields were determined. (C.E.S.)

23961 THE SUPEREXCHANGE INDUCING OF MAGNETIC FIELDS ON THE NUCLEI OF DIAMAGNETIC ATOMS. V. I. Goldanskii, V. A. Trukhtanov, M. N. Devisheva, and V. F. Belov (Inst. of Chemical Physics, Moscow). Phys. Letters, 15: 317-18(Apr. 15, 1965).

The appearance of a large magnetic field on the nuclei of diamagnetic atoms of ^{119}Sn introduced in the structure of iron garnets of formula $Y_{3-x}Ca_xSn_xFe_{5-x}O_{12}$ is reported. According to the magnetic and crystallographic studies

of such system, practically all Sn ions (at low concentrations) are located at octahedral sites and the structure formula is of the type $\{Y_{3-x}Ca_x\}[Sn_xFe_{2-x}](Fe_3)O_{12}$. The interaction of Sn ions with magnetic Fe ions in such systems seems to take place due to indirect exchange through the oxygen ions and produces quite large magnetic fields on Sn nuclei. (C.E.S.)

23962 ANHARMONIC LATTICE IN ONE DIMENSION: ENERGY SHIFT AND LIFETIME OF AN EXCITATION. C. Manohar (Atomic Energy Establishment, Trombay, India). Phys. Rev. 138: A731-2 (May 3, 1965).

The self-energy and lifetime of a long-wavelength one-dimensional phonon are calculated by Van Hove's resolvent operator formalism using the first anharmonic term. The results are valid for zero temperature. (auth)

23963 NUCLEAR MAGNETIC SHIELDING IN ALKALI HALIDE CRYSTALS. Dennis Idenberry and T. P. Das (Univ. of California, Riverside). Phys. Rev., 138: A822-8(May 3, 1965).

The overlapping-ion model proposed by Kondo and Yamashita to explain the magnetic shielding of nuclei in alkali halides is extended to derive an expression for the shielding constant σ in terms of all the important one- and two-center integrals in crystals with rocksalt structure. Using the results of Baron's pressure-dependence studies of the magnetic shielding in rubidium bromide in conjunction with the expression for σ, and using available Hartree-Fock wave functions for the ions, the average energy denominators Δ_+ and Δ_- for the Rb^+ and Br^- ions were determined. These values of Δ_+ and Δ_- are then used to calculate the values of σ_{Rb} and σ_{Br} in the crystal with reference to the free ion. When these latter quantities are combined with the experimental values of the chemical shifts with reference to dilute aqueous solution of RbBr, one obtains $\sigma_{Rb}^{aq.} = 0.63 \times 10^{-4}$ and $\sigma_{Br}^{aq.} = 1.94 \times 10^{-4}$ for the shielding constants in dilute solution relative to the free ions. (auth)

23964 Kβ X-RAY EMISSION FROM SOLID AND LIQUID ALUMINUM. David W. Fischer and William L. Baun (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Phys. Rev., 138: A1047-9(May 17, 1965).

The Kβ emission band from solid and liquid aluminum was studied using 6-kv electrons and a flat crystal x-ray spectrometer equipped with a flow counter. The Kβ band from the solid is similar to that recorded by others: very asymmetrical, rising rapidly on the short-wavelength side and tailing off slowly to longer wavelengths. At the melting point, the curve is virtually identical to that obtained from the solid. At higher temperatures, estimated to be several hundred degrees above the melting point, Kβ becomes symmetrical and very narrow, of approximately the same width as lines not involving the conduction band. It is not clear whether this narrow line originates from the surface of the liquid aluminum or from a dense gaseous aluminum layer at the surface. (auth)

23965 NORMAL VIBRATIONS OF β BRASS. G. Gilat and G. Dolling (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 138: A1053-65(May 17, 1965).

The normal modes of vibration of the ordered alloy of copper and zinc, β brass, were extensively studied at 296°K by means of the coherent one-phonon scattering of slow neutrons from single-crystal specimens. The frequencies of normal modes propagating along the high-symmetry directions [00ζ], [$\zeta\zeta$0], [$\zeta\zeta\zeta$], and [$\frac{1}{2}\frac{1}{2}\zeta$] were measured by means of a triple-axis crystal spectrometer for two specimens mounted in different orientations. These results may be satisfactorily described in terms of a restricted Born-von Kármán model (4E) with interatomic forces extending out to fourth-nearest-neighbor atoms, although Fourier analysis of sums of squares of certain normal-mode frequencies (taken in pairs) indicates the probable existence of nonzero forces extending at least to seventh neighbors. A feature of interatomic-force models for β brass is the large difference between the second-nearest-neighbor Cu–Cu and Zn–Zn forces. The experimental evidence does not, however, permit an unambiguous determination of which force is to be identified as Cu–Cu and which as Zn–Zn. A fairly successful attempt was made to interpret the results in terms of more physically realistic models, in which the effective long-range forces are represented by an oscillatory potential arising from the mild singularity in the dielectric function at the Fermi level. The precise form of the coefficient of the oscillatory potential was chosen on an empirical basis. Model 4E was used as an interpolation formula for computing the frequency distribution function and its moments, and also the heat capacity of β brass. A selection of normal modes was studied at several temperatures above 296°K, particularly in the vicinity of the order-disorder phase transition at about 727°K. The overall structure of the dispersion curves appears to be substantially unchanged in the disordered phase, although certain splittings observed at 296°K become blurred into apparently continuous bands of frequencies at elevated temperatures. In all cases, the frequencies decrease and energy widths increase as the temperature increases. Two particular longitudinal-optic modes display a sharp increase in energy width at the transition temperature, in contrast to the generally smooth behavior of the other modes. No satisfactory explanation of these effects has yet been found. (auth)

23966 DEVELOPMENT OF A PHASE TRANSITION FOR A RIGOROUSLY SOLVABLE MANY-BODY SYSTEM. C. Kittel and H. Shore (Univ. of California, Berkeley). Phys. Rev., 138: A1165-9(May 17, 1965).

The ferromagnetic transition is considered in detail for the Heisenberg hamiltonian with all spins coupled equally. For this special model the statistical problem is solved exactly. The transition develops very slowly as the number N of particles in the system is increased; the spin order at the nominal Curie temperature is proportional to $N^{-\frac{1}{3}}$. The order in the most probable state differs from the mean value of the order, except for $N \to \infty$. The connections are studied with the molecular-field, spin-wave, and self-consistent approximations. The failure of the self-consistent approximation is relatively severe as compared with the nearest-neighbor problem. The antiferromagnetic ground state is very close in energy to the Néel state. (auth)

23967 MAGNETIC BIREFRINGENCE OF EuSe. J. C. Suits and B. E. Argyle (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Rev. Letters, 14: 687-9(Apr. 26, 1965).

Measurements of Faraday rotation (magnetic circular birefringence) and Cotton-Mouton phase difference (magnetic linear birefringence) made at 4.2°K where EuSe is ferromagnetic in high magnetic fields and antiferromagnetic in low magnetic fields are reported. (C.E.S.)

23968 RELATIVISTIC ENERGY BANDS FOR TUNGSTEN. T. L. Loucks (Ames Lab., Ames, Iowa). Phys. Rev. Letters, 14: 693-4(Apr. 26, 1965). (IS-1123)

The results of an ab initio relativistic calculation of the electronic structure of tungsten are presented. The predicted splitting of the energy bands is in complete agreement with the experimental results obtained from size effect measurements. The method used was a relativistic generalization of the augmented plane wave method of Slater. (C.E.S.)

23969 DENSITY-OF-STATES EFFECTS IN THE MAGNETIC STIFFNESS OF 3d-3d TRANSITION-METAL ALLOYS. R. D. Lowde, M. Shimizu, M. W. Stringfellow, and B. H. Torrie (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Rev. Letters, 14: 698-700 (Apr. 26, 1965).

Neutron scattering results for the spin-wave stiffness constant of b-c-c 3d-3d transition metal alloys are presented and compared with a quantity obtained from an approximate density-of-states curve of these materials. The qualitative resemblance of the two figures is rather remarkable, and an explanation for this resemblance is proposed. (C.E.S.)

23970 NEW EXCITON BANDS IN KI : Na CRYSTALS CONTAINING A-CENTERS. V. Topa, L. Matei, and T.

Serban (Inst. of Physics, Bucharest). Phys. Status Solidi, 9: 55-62(1965).

Type-A centers are found in KI:Na single crystals. The conversion F → A is followed in the visible region and near the fundamental absorption edge. The intensity of the β-band decreases with the formation of A centers and at the same time a new band (β_A) is formed at longer wavelengths. The disappearance of A centers results in a broad A_c-band in the visible region which is accompanied by the formation of an α_A-band in the ultraviolet region, at wavelengths shorter than those corresponding to the α-band. As the intensities of the A_1- and β_A-bands are proportional the occurrence of the β_A- and α_A-bands can be explained qualitatively by exciton formation near A centers or vacancies which are due to negative ions with a Na ion as nearest neighbor. (auth)

23971 SPECIFIC HEAT, NEUTRONS, AND PHONONS. W. Cochran (Cambridge Univ., Eng.). Sci. Progr. (London), 51: 424-9(July 1963).

The use of a slow-neutron beam for investigating dynamics of atoms in crystals is described. Slow neutrons, with wavelength and energy close to those of lattice waves, are suitable for studying thermal excitations in solids and liquids. Equations for the interaction of a neutron beam with a crystal with emission of a single phonon are given. A nuclear reactor is used for an intense neutron source. In one experimental technique, the time of flight of neutrons monochromatized by a chopper and scattered by the crystal into a counter is recorded. In a second type of experiment, the beam is monochromatized by Bragg reflection in a large monocrystal and scattered by the specimen crystal; the neutron wavelength is measured from the angle of reflection from a third crystal, the analyzer. These techniques were used to study lattice waves in several elements and simple compounds. The results for Na are shown. These results are important for understanding practically all the macroscopic properties of perfect crystals and give information on interatomic forces in crystals. (M.J.T.)

23972 SPECTROPHOTOMETRIC STUDY OF THE COLOUR CENTERS OBTAINED BY DIFFERENT METHODS IN ALKALI HALIDES. E. Badareu, Ath. Trutia, and V. Topa (Inst. of Physics, Bucharest). Rev. Roumaine Phys., 9: 631-6(1964).

Color centers, obtained by various methods (additive, electrolytic, X rays and ultraviolet radiations) in KCl and NaCl monocrystals containing Ca^{++} and OH^- impurities are studied. In KCl with Ca^{++} impurity, colored by X rays or ultraviolet radiations at room temperature, the V_2 band appeared. There is no such band in NaCl–Ca^{++}. Additive and especially electrolytic coloration produces the most spectacular change in the crystals giving evidence of the impurity. (auth)

23973 LATTICE VIBRATIONS OF TUNGSTEN. S. H. Chen and B. N. Brockhouse (McMaster Univ., Hamilton Ont.). Solid State Commun., 2: 73-7(Mar. 1964).

The frequency-wave number dispersion relations of the lattice vibrations in the symmetric directions of bcc W at room temperature were measured by neutron inelastic scattering. The measurements were made with a triple-axis crystal spectrometer using the constant-Q method. The results in the three major directions [001], [110] and [111] are reported, together with a Born–Von Kármán general-force-model analysis from which the range and magnitude of the forces between the atoms in this metal are inferred. The connection between the results and the unusual elastic behavior of tungsten is discussed. (auth)

23974 MAGNETORESISTANCE IN RARE EARTH SINGLE CRYSTALS. A. R. Mackintosh and L. E. Spanel (Ames Lab., Ames, Iowa). Solid State Commun., 2: 383-6 (Dec. 1964).

The magnetoresistance of single crystals of holmium and dysprosium was measured over a wide temperature range in the region of magnetic ordering. The results reflect the modification of the Fermi surface and the changes in the spin wave scattering of the conduction electrons when the magnetic ordering changes. When a large field is applied along the magnetically easy direction and the magnetic periodicity is destroyed, a large decrease in the ⟨0001⟩ direction is observed, primarily due to the removal of super-zone energy gaps in the electron dispersion curves. Changes of resistivity in the basal plane are thought to be mainly a consequence of changes in the spin wave spectra. A short discussion is given of the motion in a magnetic field of an electron in a periodic magnetic structure. (auth)

23975 X-RAY SPECTRAL INVESTIGATION OF SAMARIUM HEXABORIDE. E. E. Vainshtein, S. M. Blokhin, and Yu. B. Paderno (Inst. of Inorganic Chemistry, Academy of Sciences, Siberian SSR and Inst. of Special Alloys and Cermets, Academy of Sciences, Ukrainian SSR). Soviet Phys.-Solid State (English Transl.), 6: 2318-20(Apr. 1965). Translated from Fiz. Tverd. Tela, 6: 2909-12(Oct. 1964).

The x-ray L-absorption spectra of samarium hexaboride and of europium and ytterbium hexaborides and oxides were measured. For samarium hexaboride measurements were made at several temperatures from 20 to 400°C. The main absorption edge of samarium hexaboride was plotted theoretically, in agreement with the experimental curve, by assuming that the compound contains statistically distributed divalent and trivalent samarium atoms. (D.C.W.)

23976 PHONON CORRELATION FUNCTION AND COHERENT INELASTIC SCATTERING OF NEUTRONS IN CRYSTALS CONTAINING SHALLOW ELECTRON IMPURITY CENTERS. M. A. Krivoglaz and P. I. Shaldervan (Inst. of Metal Physics, Kiev). Soviet Phys.-Solid State (English Transl.), 6: 2618-23(May 1965). Translated from Fiz. Tverd. Tela, 6: 3272-8(Nov. 1964).

The electron-phonon interaction in crystals containing shallow electron centers is analyzed. The phonon correlation function and its frequency shift and damping are determined. The calculation is carried out in a higher than normal approximation, including finite lifetimes of electron states. This permits the elimination of divergences related to the resonance nature of the interaction. The effect of the phonon interaction with localized centers on the energy distribution of scattered neutrons is investigated. Estimates show that this interaction may result in a marked change in the magnitude of phonon damping and also in a change of the width and shape of the energy distribution of scattered neutrons. (auth)

23977 INTERACTION OF AN ULTRASONIC WAVE WITH A BEAM OF CHARGED PARTICLES. Sh. M. Kogan and V. B. Sandomirskii (Inst. of Radio Engineering and Electronics, Moscow). Soviet Phys.-Solid State (English Transl.), 6: 2763-7(May 1965). Translated from Fiz. Tverd. Tela, 6: 3457-63(Nov. 1964).

The amplification of ultrasound in a piezoelectric dielectric by a beam of charged particles moving in a narrow gap inside the crystal is analyzed. Two limiting cases are investigated, differing in the magnitude of the ultrasonic wave vector in the direction perpendicular to the gap. The effect has a resonance type behavior (as in a traveling-wave tube), which distinguishes it in principle from the amplification of ultrasound by current carrier drift. (auth)

23978 ON THE QUANTUM THEORY OF TRANSPORT PROCESSES IN MAGNETIC FIELDS. III. PHONON DRAG. Sighart Fischer (Universitat, Gottingen, Ger.). Z. Physik, 184: 325-38(1965). (In German)

The electric, thermoelectric, and thermal transport coefficients are calculated in the presence of a transverse magnetic field, taking into account phonon drag. The calculations are based on the model of free electrons, phonons, and impurity scatters. An integral equation (generalized transport equation) is developed, starting from Kubo's formulas and using truncation technique for the Green's functions. It is solved in the case of strong magnetic field. If phonon drag is neglected, Titeica-type formulas hold for all transport coefficients. Phonon drag reduces the values in the sense that the electron-phonon relaxation time is replaced by the sum of the electron-phonon and phonon-scatterer relaxation time. (auth)

23979 FLUORINE HYPERFINE STRUCTURE OF THE EPR SPECTRA OF U^{3+}, AND Tb^{3+} IONS IN CaF_2. B. G. Berulava, T. I. Sanadze, and O. G. Khokhanashvili (Tbilissi State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 48: 437-41(Feb. 1965). (In Russian)

The spectra of the fluorine hyperfine structure of U^{3+} and Tb^{3+} surrounded by tetragonal symmetry in the CaF_2 lattice are investigated. Interaction between the paramagnetic ion and surrounding is of an asymmetric nature and partially includes the second coordination sphere of the F^- ions. (auth)

23980 A SPECTRAL STUDY OF INDUCED RADIATION FROM Nd^{3+} IN CaF_2. A. A. Kaminskii, L. S. Kornienko, and A. M. Prokhorov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 48: 476-82(Feb. 1965). (In Russian)

The spectral radiation produced by the transition $^4F_{\frac{3}{2}} \rightarrow {}^4I_{11/2}$ of the Nd^{3+} ion in CaF_2 is studied experimentally at temperatures between 300 and 15°K. The results of investigation of electron paramagnetic resonance are compared with those of induced radiation studies. The wavelengths of five new generation lines are reported. (auth)

23981 PROPAGATION OF ELECTROMAGNETIC WAVES IN METALS; EFFECT OF FERMI FLUID INTERACTION. A. Ya. Blank and V. L. Falko (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 48: 742-7(Feb. 1965). (In Russian)

The spectrum and damping of electromagnetic excitations in a metal located in a strong magnetic field is considered by taking into account Fermi fluid interaction. In some cases an investigation of weakly damped waves yields the magnitude of the correlation function for the Fermi fluid electrons in the metal. (auth)

23982 ELEMENTARY EXCITATIONS IN SOLIDS. Lectures on Phonons, Electrons, and Plasmons. David Pines. Lecture Notes and Supplements in Physics. New York, W. A. Benjamin, Inc., 1964. 310p.

Phonons are considered, including lattice dynamics and specific heat, neutron scattering in solids, and phonon-phonon interactions. Electrons and plasmons are discussed, with consideration of the Sommerfeld noninteracting gas, the Hartree and Hartree-Fock approximations, correlation energy, dielectric response, and electron gases in the RPA and at metallic densities. Observations and models on electrons, plasmons, and photons in solids are reviewed. The electron-phonon interaction in metals is described, considering phonon frequencies, electron-electron interactions, approach to equilibrium, conductivity, relaxation time, and quasi-particle properties. (M.J.T.)

23983 EFFECTS OF PHONON INTERACTIONS ON THE SCATTERING OF NEUTRONS BY CRYSTALS. Jacobus Jean Jacques Kokkedee. Thesis, Utrecht, Rijksuniversiteit, [1962]. 64p.

The influence of phonon interactions on the position and broadening of the peaks in thermal neutron scattering by perfect single crystals was studied for finite temperature by means of the many particle perturbation theory. A systematic, theoretical treatment is presented for nonconducting (phonon-phonon interactions) and conducting crystals (phonon-phonon plus electron-phonon interactions), restricted to the case where the width of the peak is small compared to the value of the frequency. A detailed analysis of the summed diagrams leads to the partial scattering function, from which expressions for the shift and width were obtained and explicit calculations were performed. Calculations for the lowest order contribution of the electron-phonon coupling to the broadening of the peaks indicates that the relative influence on the one-phonon peaks is expected to be small, except at very low temperatures. (L.B.S.)

23984 COLLECTIVE EXCITATIONS OF ELECTRON-HOLE SYSTEM IN THE π-BAND OF GRAPHITE. Yoshi H. Ichikawa (Nihon Univ., Tokyo) and Kenji Kobayashi. Session I, Paper 3 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

Possible modes of collective oscillations of the conduction electrons and holes of π-band in graphite were investigated. Interactions between the carriers and lattice vibration and impurity scattering were neglected. The analysis showed that the optical properties of graphite exhibit the effects of plasma oscillations in the infrared region. (M.C.G.)

23985 ELECTRON ENERGY STRUCTURE OF RHOMBOHEDRAL AND TURBOSTRATIC GRAPHITES. J. W. McClure (Univ. of Oregon, Eugene). Session I, Paper 4 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

Haering's calculation for rhombohedral graphite was extended to include interactions between next-nearest layers. A unit cell in k space, which was a hexagonal cylinder identical with the double zone sometimes used for the Bernal structure, was used. In agreement with Haering, it was found that the two π bands are degenerate along spirals, which are centered on the vertical zone edges, and which make one complete turn in the cell height. It was concluded that pure rhombohedral graphite has both electrons and holes present at all temperatures. The model used for turbostratic graphite assumed that adjacent levels are oriented so as to form Moiré patterns. Systems of equations whose solution would yield the electron energies are given. Possible forms of the solutions of the equations are considered. (M.C.G.)

23986 SOME COMMENTS ON LATTICE DYNAMICS OF TURBOSTRATIC GRAPHITE. Claude A. Klein (Raytheon Co., Waltham, Mass.). Session I, Paper 6 of "Symposium on Carbon." Tokyo, Carbon Society of Japan, 1964. 4p.

Dispersion curves for acoustical phonons propagating along and across the basal planes of turbostratic graphite are given. Reduced wave number is plotted versus phonon frequency for both in-plane and out-of-plane lattice vibration modes. (M.C.G.)

23987 MAGNETOACOUSTIC EFFECT ON TUNGSTEN AND MOLYBDENUM NEAR 1 GC/SEC. C. K. Jones (Westinghouse Research Labs., Pittsburgh) and J. A. Rayne. 13p. (CONF-651-87)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Magnetoacoustic measurements on high-purity tungsten and molybdenum were made at frequencies up to 0.93 Gc/sec. From the observed oscillatory behavior, the extremal dimensions of the Fermi surface were deduced as a function of crystal orientation. The results were compared with the predictions of the Lomer model and deHaas-van Alphen data. (auth)

23988 A NUCLEAR RESONANCE STUDY OF CaF_2: Eu^{2+}. S. M. Day, G. B. Grimes, Jr., and W. Weatherford (Univ. of Arkansas, Fayetteville). 25p. (CONF-640606-23)

From American Physical Society Summer Meeting, Denver.

The work of Rorschach on the interactions of dipolar nuclei with paramagnetic impurities in dielectric crystals under experimental conditions which lead to the rapid diffusion expression for the spin-lattice relaxation time is extended. The influence of the average "static" moment on the nuclear resonance linewidth as calculated from Van Vleck's method of moments is considered. Also experimental results are reported for nuclear resonance studies of $CaF_2:Eu^{2+}$ which agree with the theoretical results for both the nuclear relaxation time and the nuclear resonance linewidth. By using both results, more reliable information about the paramagnetic ions and their behavior in the crystal can be obtained. Specifically, the magnetic field, temperature, and orientation dependence of the auto-correlation time of the impurity can be obtained, as well as an estimate of its magnitude of the ionic concentration. (auth)

23989 ON THE SPIN SUSCEPTIBILITY OF LANDAU'S FERMI LIQUID. A. M. de Graaf and R. Luzzi (Univ. of Sao Paulo, Brazil). 15p. (CONF-651-84).

From 9th International Conference on Low Temperature Physics, Columbus, Ohio.

The Landau theory of the Fermi liquid is used to analyze the spin susceptibility of a large electron system with repulsive interactions for space-dependent fields. The induced spin density is determined by the solutions of an integral equation of the form obtained by Wolff using the generalized random phase approximation. Solutions of this equation are obtained for some special cases. In particular, Sawada's and Twamoto's conditions for the instability of the plane-wave Hartree-Fock state with respect to the ferromagnetic state are obtained from the singularities of the bulk susceptibility. Further, it is shown that for electron densities characteristic of normal metals, the susceptibility in momentum space has a maximum, if not a singularity for finite wave number. (auth)

23990 POSITRON ANNIHILATION IN V_3Si. T. W. Mihalisin and R. D. Parks (Univ. of Rochester, N. Y.). 13p. (CONF-651-85)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The angular correlation between the two gamma rays emitted when a thermalized positron annihilates with a conduction electron was measured for single crystals of V_3Si oriented in the (100) and (111) directions. The results indicate that the Fermi surface of V_3Si is isotropic to within a few per cent, in disagreement with Weger's model by which an unusual, anisotropic Fermi surface for the 3d electrons in V was calculated, considering only nearest neighbor interactions. A proposed experiment is described in which the difference in the momentum distribution of the electrons in the normal and superconducting states of V_3Si will be measured. (D.C.W.)

REACTOR TECHNOLOGY

General

Refer also to abstracts 22595 and 22864.

23991 (ANL-7003) REACTOR DEVELOPMENT PROGRAM. Progress Report, January 1965. (Argonne National Lab., Ill.). Feb. 18, 1965. Contract W-31-109-eng-38. 87p. Dep.; $3.00(cy), 2(mn) CFSTI.

Research progress is reported on fast reactor physics, 1000-Mwe metal-fueled fast-breeder reactor design, fast reactor fuels, fuel processing, EBR-II, and FARET development, reactor and nuclear physics, high-temperature materials, reactor engineering, separation processes, Pu recycle reactors, Argonne Advanced Research Reactor design, regenerative fuel cells, and nuclear safety. A list of papers and reports published during the period is included. (J.R.D.)

23992 (CONF-640607(Vol.I)) SYMPOSIUM ON IN-CORE INSTRUMENTATION, OSLO, JUNE 15-19, 1964. VOLUME I. (European Nuclear Energy Agency, Paris (France) and Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). 503p. Dep.(mn).

Twenty-six papers are included; separate abstracts have been prepared for 19. Seven papers were previously abstracted in NSA, 19: 753, 3633, 3634, 3635, 3637, 3638, and 3639. (T.F.H.)

For abstracts of individual papers see: 22682, 22689, 24005, 24006, 24007, 24008, 24009, 24010, 24011, 24012, 24013, 24068, 24069, 24070, 24164, 24165, 24166, 24167, and 24168.

23993 (CONF-640607(Vol.II)) SYMPOSIUM ON IN-CORE INSTRUMENTATION, OSLO, JUNE 15-19, 1964. VOLUME II. (European Nuclear Energy Agency, Paris (France) and Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). 520p. Dep.(mn).

Twenty papers, one reprint of a journal article, and summaries of proceedings of 8 panel meetings are included. Separate abstracts have been prepared for 12 of the papers, and for the summary of proceedings. Eight papers were previously abstracted in NSA, 19: 3640, 3643, 3644, 3645, 3646, 3647, 3648, and 3650. The reprinted journal article was previously abstracted in NSA, 18: 10408. (T.F.H.)

For abstracts of individual sections see: 22478, 22655, 22656, 22657, 22658, 23994, 24014, 24015, 24071, 24072, 24073, 24169, and 24170.

23994 (CONF-640607(Vol.II)(Paper H)) [RECORD OF PANELS 1 THROUGH 8]. (European Nuclear Energy Agency, Paris (France) and Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). 30p.

Panel meetings on the development, design, fabrication, uses, and operations of various types of in-core reactor instruments are summarized. (T.F.H.)

23995 (HW-83298) RESEARCH AND DEVELOPMENT PROGRAMS EXECUTED FOR THE DIVISION OF REACTOR DEVELOPMENT. Quarterly Progress Report, April–June 1964. J. K. Green, ed. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 1964. Contract AT(45-1)-1350. 200p. Dep.; $5.00 (cy), 4(mn) CFSTI.

Progress in the various areas of work are reported in sections on analytical studies and advanced concepts, chemical research and development, fuel studies, gas-cooled reactor studies, instrumentation and nondestructive testing, irradiation effects on materials, materials development, physics studies, and Plutonium Recycle Test Reactor development. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 22405, 22660, 22869, 22895, 23124, 24030, 24083, 24084, and 24085.

23996 (ORNL-3650(p.1-110)) REACTOR DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

Progress is reported on Experimental Gas-cooled Reactor, materials studies, irradiation tests and studies German pebble-bed reactor, fueled graphite program, fast gas-cooled reactors, molten salt reactor program, High-flux Isotope Reactor, army reactors program, space reactor program, thorium utilization program, reactor shielding, reactor physics, reactor fuels and materials, reactor components, fuel processing, nuclear safety, and waste disposal. (J.R.D.)

23997 (ORNL-3776(p.107-8)) SIMULATED TRANSIENT ACCIDENTS IN TREAT. G. W. Parker, R. A. Lorenz, and J. G. Wilhelm (Oak Ridge National Lab., Tenn.).

Transient melting of reactor fuels can, under some conditions, represent a more severe accident condition than the loss-of-coolant accident. The fifth and sixth of a series of experiments being performed in the TREAT facility to determine the release of fission products from transient-heated UO_2 fuels were completed, but data on the distribution of released fission products are not yet available. One specimen was clad with 347 stainless steel, as were the first four specimens of the series, and the other was Zircaloy clad. The UO_2 had been previously irradiated to a burnup of 50 Mwd/t. Both specimens were preheated to 400°C, and melting occurred in steam at 1000 psi. The transient selected should have melted about 75% of the UO_2. (auth)

23998 (TID-21733) NORA PROJECT. Summary Report [for] Period 1961–1964. (Institutt for Atomenergi, Kjeller (Norway)). Feb. 1965. Contract [AT(30-1)-2466]. 123p. (NC-63). Dep.(mn); $4.00(cy), 3(mn) CFSTI.

The NORA research program on the fundamental physics of D_2O/H_2O-moderated reactors fueled with slightly enriched UO_2 is summarized. The experimental program using the NORA zero power reactor and the JEEPNIK miniature assembly are described. Efforts in theoretical research devoted to development of the K-7 THERMOS and BIGG multigroup programs are summarized. Computer programs from other laboratories used in analyses of experiments are noted. These programs include DATA-PREP-I for thermal neutron disadvantage, BURNUP for heavy water reactor lattice parameters, and SANDPIPER-I for survey and buckling calculations. Another program used in the NORA project is a two-group version which solves multi-energy group neutron diffusion equations. It is noted that the most important reactor physics research comprised the moderator experiments. Analysis of the NORA experiments appears to be the most important theoretical work. (J.R.D.)

23999 INSTITUTT FOR ATOMENERGI (IFA) (KJELLER AND HALDEN). Euro Nucl., 2: 137-44(Mar. 1965).

Organization of the Norwegian Institutt for Atomenergi (IFA) is reviewed. The JEEP Reactor, the JEEP II Reactor, the Halden Reactor, and the NORA zero-energy facility are described. Research on ship propulsion, physics, chemistry, isotope production, and metallurgy is reviewed. (M.C.G.)

24000 NUCLEAR ENGINEERING. ANNUAL SURVEY. Guenter Wiesenack. VDI (Ver. Deutr. Ingr.) Z., 107: 187-202(Feb. 1965). (In German)

A bibliographic review is made of the most important nuclear engineering studies made in 1964 on nuclear power plants, nuclear fuel elements and materials, use of radioisotopes in industry, radiation protection, and legal and insurance aspects. (J.S.R.)

24001 ATOMKERNREAKTOREN. 2. ERWEITERTE AUFLAGE. (Nuclear Reactors. II. Expanded Edition). W. Kliefoth. Schriftenreihe des Deutschen Atomforums e. V., Heft 2. Bonn, Deutschen Atomforum e.V., 1964. 72p.

The fundamentals of reactor physics and technology are briefly reviewed. The characteristics of the research and power reactors of West Germany are discussed. The acceleration of reactor development though the European Atomgemeinschaft is considered. (J.S.R.)

24002 SOME NUCLEAR CODES DEVELOPED AT THE COMPUTING CENTER OF ISPRA. I. Galligani, C. Mongini Tamagnini, and C. Ponti (EURATOM-CCR, Ispra, Italy). 11p. (CONF-654-86)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The development of fast codes for reactor survey or burnup problems is discussed. Included are schemes for averaged thermal cross sections for each reactor region, fast cross sections, and multigroup multidimensional equations in diffusion or transport approximations. One such code, THESIS II, for flux distributions and averaged multigroup thermal cross sections in homogeneous media is described. THESIS II features a 3-second running time on IBM 7090. (R.E.U.)

Auxiliaries and Components

Refer also to abstract 22689.

24003 (CEA-Bib-49) CIRCUITS DE REFROIDISSEMENT DES PILES A METAUX LIQUIDES. (Cooling Loops in Liquid Metal Piles). Myriam Aberdam and Gilbert Gros (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleares). Feb. 1965. 315p. Dep.(mn).

A review is presented on the cooling loops of the principal fast and thermal liquid metal cooled reactors presently in operation, built, being built, or planned. It is divided into two volumes; volume I includes the text and the bibliographical section; volume II, the figures, specification tables, and comparative tables that are cited in the text. The generalities of each of the different studied reactors (history, fuel, power, etc ...) are described; then each part of the primary and secondary cooling loops (pumps, heat exchangers, flowmeters, traps, etc ...) is treated separately where the main characteristics of the reactors are successively described. 163 references, which are subsequently classified by part of the loops and by reactor name, are included. (auth)

24004 (CEA-R-2373) CONTRIBUTION A L'ETUDE ET A L'UTILISATION DES CHAMBRES D'IONISATION POUR LE CONTROLE DES REACTEURS NUCLEAIRES. (Contribution to the Study and Use of Ionization Chambers for Nuclear Reactor Control). Jean Duchêne (Commissariat à l'Énergie Atomique, Saclay (France). Centre d'Études Nucléaires). 1965. 92p. Dep.(mn).

Thesis submitted to Université, Paris.

A contribution to reactor control techniques is made that consists, on one-hand, in an attempt to make a synthesis of the factors influencing the operation of ionization chambers and the study of these factors, and on the other hand, in the development of ionization chambers of the fission and boron types, making it possible to follow the working of a reactor from the moment it starts up until maximum power is attained. In the field of fission chambers the technique for depositing uranium oxide on aluminum and the electrolytic deposition process on other metals (stainless steel, copper, molybdenum, nickel, tantalum, titanium, kovar, tungsten, and beryllium) are improved. Several types of fission chambers used during the start-up of reactors are developed: one type of medium performance now in use in French piles; one high-sensitivity type; and one high-temperature type, which has operated up to 600°C. As far as boron chambers are concerned, perturbations caused by the exposure of the chamber to high neutron flux and to a very strong γ radiation are studied. This exposure brings about a modification of the properties of the constituent materials and causes a background noise in the chamber, which can seriously handicap the neutron measurements. The compensation technique is shown to make possible this noise and thereby to increase the range of measurement of conventional ionization chambers intended for power measurements. (auth)

24005 (CONF-640607(Vol.I)(Paper A-1)) PRESENT STATUS AND FUTURE INCORE INSTRUMENTATION PROGRAMME IN AUSTRIA. M. J. Higatsberger, A. Burtscher, and H. Schmidl (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf (Austria)). 5p.

The first nuclear reactor ASTRA became critical on September 25th, 1960 at Austria's National Reactor Center The power level of this light water pool tank type research and test reactor can be raised to 12 Mw, but 5 Mw has not been exceeded. Two more reactors for research purposes have been built in Austria, the TRIGA/II Reactor at the Atomic Institute of the Technical University of Vienna and a Siemens Argonaut Reactor at the Technical University of Graz. The latter will start operation in the second half of 1964, while the TRIGA reactor has been in use for research and training purposes since 1962. A design study on a pressurized power reactor is being carried out. In-core instrumentation work so far has been carried on at ASTRA and the Reactor Development Institute of the Reactor Center at Seibersdorf. The work of the Reactor Development Institute is concerned with cold in-core instrumentation. The ASTRA reactor institute has been attaching its work to the present hot core of ASTRA. On the pressurized power reactor, the planning on proper in-core instrumentation is under way. (auth)

24006 (CONF-640607(Vol.I)(Paper A-2)) IN-PILE INSTRUMENTATION IN BELGIUM. J. Storrer (Societe Belge pour l'Industrie Nucleaire, Brussels (Belgium)). 6p.

The design and development of instrumentation for the cores of the BR2, BR3, Vulcain, and SENA reactors is summarized. (T.F.H.)

24007 (CONF-640607(Vol.I)(Paper A-3)) IN-CORE INSTRUMENTATION AT C.R.N.L. R. C. Hawkings (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 19p.

The status of in-core instrumentation at Chalk River Laboratories, Canada, is reviewed, with attention to low- and high-temperature thermocouples, measurement of thermal expansion and strain, measurement of gas pressures, indicating neutron-flux monitors, and dosimetry of reactor radiation. (T.F.H.)

24008 (CONF-640607(Vol.I)(Paper A-5)) FINLAND'S INTEREST IN IN-CORE INSTRUMENTATION. S. O. Hultin and E. N. Westerberg (Voimayhdistys Ydin, Helsinki (Finland)). 2p.

Planned in-core instrumentation programs in Finland are discussed. (T.F.H.)

24009 (CONF-640607(Vol.I)(Paper A-8)) IN-CORE INSTRUMENTATION IN THE NETHERLANDS. E. K. Hoekstra (Netherlands'- Norwegian Reactor School, Kjeller (Norway). Advanced Study Inst.). 11p.

A review is presented of the development of instrumentation for the 50-Mw(e) boiling-water SEP Netherlands' reactor, and of instrumentation development and applications at the Reactor Centrum Nederland and the Netherlands universities. (T.F.H.)

24010 (CONF-640607(Vol.I)(Paper A-10)) A SUMMARY OF IN-CORE INSTRUMENTATION WORK AT KJELLER. Helge Christensen (Institutt for Atomenergi, Kjeller (Norway)). 7p.

In-core instrumentation development at Kjeller is noted. (T.F.H.)

24011 (CONF-640607(Vol.I)(Paper A-11)) SOME PRESENT IN-CORE INSTRUMENTATION DEVELOPMENT WORK IN SWEDEN. G. Jonsson (Aktiebolaget Atomenergi, Studsvik (Sweden)). 11p.

The development of instrumentation for monitoring fuel integrity in heavy-water power reactors, and for monitoring in-core neutron fluxes, is discussed. (T.F.H.)

24012 (CONF-640607(Vol.I)(Paper A-13)) SOME RECENT WORK ON IN-PILE INSTRUMENTATION AND MEASUREMENTS IN THE U.K.A.E.A. D. Harrison (Atomic Energy Establishment, Winfrith (England)). 8p.

Instruments are described that are designed for in-pile thermal measurements, measurements in coolants and moderators, measurements of nuclear parameters, detection of failed fuel elements, coolant level detection, and position sensing. (T.F.H.)

24013 (CONF-640607(Vol.I)(Paper A-14)) SOME IN-VESSEL INSTRUMENTATION PROGRAMS REPRESENTATIVE OF THE UNITED STATES. E. J. Brooks (Argonne National Lab., Idaho Falls, Idaho). 4p.

A notable degree of success in making in-vessel measurements has been attained on several reactors in the United States. Both experimental reactors and those linked to electric-power-producing facilities of private utilities systems have been equipped to monitor reactor performance for the benefit of designers and operators. Measurements of temperatures are carried out with accuracy, and the introduction of reliable miniature ionization chambers has led to their use in the safety system of at least one large reactor. Two-phase flow measurements are made with turbine-type meters, but bearing failures remain as an objection to use of these devices. Ultrasonics has been applied to determination of the true steam-water interface in a boiling water reactor, and to another experimental device which shows promise as a boiling detector for pressurized water systems. Fuel temperature measurements in UO_2 pellets have been accomplished, and experiments on a thermocouple design show promise for its usefulness at temperatures approaching 5000°F in UO_2. (auth)

24014 (CONF-640607(Vol.II)(Paper D-4)) BEHAVIOUR OF IRRADIATED THERMOCOUPLES — EXPERIMENTAL INVESTIGATIONS. P. Lupoli, G. Bianchi, and S. Moretti (Comitato Nazionale per l'Energia Nucleare, Ispra (Italy)). 35p.

Effects of radiation damage upon thermocouple calibration curves are studied. Sixteen thermocouples of different materials and manufacture are irradiated by means of a rig equipped with four graphite crucibles, each containing a melting metal. This setup provides four reference points for calibration in situ. Another batch of nickel-based thermocouples is calibrated after irradiation in a hot facility. Irradiation is performed at the ISPRA-1 Reactor, and lasts for about nine months, with a total integrated neutron flux of about 4×10^{20} nvt. Temperature ranges between 200 and 650°C. Results are discussed, together with the major difficulties encountered both in providing reference calibration points in-pile and in calibrating very highly active thermocouples out-of-pile. (auth)

24015 (CONF-640607(Vol.II)(Paper G-2)) THERMOCOUPLE DEVELOPMENT PROGRAMME AT PETTEN. van der Kley (Reactor Centrum Nederland, The Hague (Netherlands)). 3p.

Materials and irradiation studies carried out for the development of in-pile thermocouples are outlined. (T.F.H.)

24016 (GEMP-87) REACTOR INSTRUMENTATION AND CONTROL PROGRESS REPORT NO. 87. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Mar. 31, 1965. Contract AT(40-1)-2847. 17p. Dep.; $1.00(cy), 1(mn) CFSTI.

Research and development work on a stable probe-type temperature sensor is reported. Tests were made during the period in non-oxidizing atmospheres using single-crystal alumina sensors in conjunction with readout circuitry. Tests of the single-crystal alumina sensor probe were also made in oxidizing atmospheres. Results are included from stability and response time tests. Work on advanced nuclear sensors is also reported in which an a-c chamber was built and tested at 538°C under gamma irradiation. A long-term test of an a-c regulating-rod control system was initiated to evaluate drift and reliability in system components. Evaluation of charged-fragment neutron sensors was continued, and capture-gamma neutron sensors were investigated along with gamma-activated power sources. (J.R.D.)

24017 (ORNL-TM-855) A HIGH TEMPERATURE ENVIRONMENTAL TEST FACILITY AND TEST PROGRAM FOR THE EGCR CONTROL ROD DRIVE. W. F. Ferguson and E. Storto (Oak Ridge National Lab., Tenn.). Mar. 1965. Contract W-7405-eng-26. 20p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

A test facility has been constructed in which it is possible to mock-up the Experimental Gas-Cooled Reactor graphite moderator configuration and to simulate reactor operating conditons with regard to temperature, pressure, type of coolant gas, and coolant flow rate. The facility has been used to conduct performance tests on the EGCR control rod drive mechanism and appurtenances. A description is given of the test facility, the EGCR control rod drive mechanism, and the program for testing of a prototype EGCR control rod drive mechanism and appurtenances. (auth)

24018 BETTER COMPONENTS FOR NUCLEAR REACTOR SYSTEMS. Atomics, [18:] 11-20(Mar.-Apr. 1965).

A survey of progress in nuclear reactor component developments is presented. Boiling water reactors, pressurized water reactors, heavy water reactors, organic moderated reactors, gas-cooled reactors, and sodium-cooled reactors are discussed. Developments in reactor vessels, steam generators, circulating pumps, valves, in-core instrumentation, fuel-handling equipment, and control rod systems are also considered. (C.E.S.)

24019 FUEL HANDLING. R. Martin (Commissariat a l'Energie Atomique, [Paris]). Bull. Inform. Sci. Tech. (Paris), No. 79, 53-64(1964). (In French). (EUR-1179.f)

Fuel handling represents one of the main mechanical problems bound up with gas-graphite reactors; it is particularly difficult to overcome when refueling is required during reactor operation. A concise account of the basic solution generally adopted and the fundamental principles to be observed is followed up by an original concept, bearing on the use of an "integral design" fuel-handling machine, i.e., one which is located in a special built-in compartment above the pressure-vessel and separated from the core by a shielding slab with a penetration for each channel. The fuel-handling machine, which is unshielded, is simple and light in construction. An analysis is given of the numerous advantages afforded by this design, which is made possible by the various technological advances achieved (prestressed concrete pressure vessels, increased lattice pitch, reversal of normal direction of air flow). The specially designed repair function has been provided with a simple solution. Trials on a full-scale mock-up have been launched at Saclay in order to form an opinion on the validity of the proposed device. (auth)

24020 SPECIAL PHYSICO-CHEMICAL PROBLEMS RELATED TO THE USE OF HEAVY WATER IN REACTORS. G. Dirian. Bull. Inform. Sci. Tech. (Paris), No. 87, 55-67(Oct. 1964). (In French)

The problems of reducing losses to a minimum and of maintaining isotopic purity in heavy-water reactors are reviewed, considering aspects of the physical chemistry of water in reactors. Effects of radioactivation of heavy water, sources of isotopic pollution, and sources of water losses are discussed. Present solutions to these problems are found satisfactory, and improvements are being brought about. The use of heavy water does not seem to introduce special difficulties in power reactor operation. (M.J.T.)

24021 AUTOMATIC REACTOR CONTROL BY MEANS OF A COMPUTER. Sc. Takamatsu, et al. Genshiryoku Kogyo, 9: No. 6, 9-14(1963). (In Japanese)

The theory, methods, and equipment used in the application of a computer in reactor startup and control are described. Three BF_3 detectors were used for neutron measurements. The signal obtained after amplification was used as a startup signal for a computer. The signals are collected directly and sent to a memory circuit, passed through a gating circuit, and then to an operating circuit for conversion to period and power. (IIC-M.G.)

24022 COUPLING DEVICES FOR LIFTING ARTICLES. Dennis William Guiver (to Flight Refuelling Ltd.). British Patent 980,978. Jan. 20, 1965. Filed Sept. 28, 1962.

The device patented for coupling lifting apparatus to articles to be lifted or lowered has its main application in connection with nuclear reactors, where it can be used

for removing and replacing closure plugs. The device consists essentially of inner and outer sleeves adapted for attachment to lifting apparatus and rotatable one relative to the other through a predetermined angle. Radially movable locking and lifting members are mounted in holes in one of the sleeves. The device is arranged to release the locking means that holds the plug in position before lifting and to remain coupled to the plug after lowering until the locking means is fully engaged. (A.G.W.)

24023 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 981,565. Jan. 27, 1965. Priority date Feb. 28, 1961, United States.

A method for varying the reactivity of the core of a nuclear reactor by addition or removal of neutron absorbent material is described. Conduits extending from outside into the core contain neutron absorbent material freely movable under the influence of fluid flowing through the conduit. Control means are arranged to vary the flow of fluid through the conduits between a condition of maximum insertion of the absorbent material and a condition of maximum withdrawal. The neutron absorbent material is in the form of balls of diameter slightly smaller than the inside diameter of the conduits, and the conduits may be so arranged that the movement of the balls into the core is caused or assisted by gravity. The fluid may be the reactor coolant, or a separate source of pressurized fluid such as nitrogen may be used. (A.G.W.)

24024 IMPROVEMENT IN OR RELATING TO GAS COOLED NUCLEAR REACTORS. Kenneth Barker (to United Kingdom Atomic Energy Authority). British Patent 981,927. Jan. 27, 1965. Filed Jan. 23, 1963.

A gas-cooled nuclear reactor having a core supported within a pressure vessel on a support structure and having channels for reactor coolant gas extending vertically through the core is arranged so that the gas flows downwardly into a hot gas plenum chamber beneath the core. Ducts are arranged to extend through the plenum chamber to communicate the underside of the support structure with a supply of cool gas. The plenum chamber is suspended from the support structure by tie rods that extend within the ducts. (A.G.W.)

24025 CONTROL MECHANISM FOR A NUCLEAR REACTOR CONTROL ROD. Joseph Thouvenot (to Commissariat a l'Energie Atomique). British Patent 981,940. Jan. 27, 1965. Priority date Oct. 30, 1962, France.

The control mechanism patented includes a rotatable hollow shaft and a toothed rack at least partly within the shaft and axially displaceable relative to the shaft. The rack is connected to the control rod, and transmission means between the shaft and rack cause axial displacement of the rack in response to rotation of the shaft. (A.G.W.)

24026 GRIPPER SYSTEM FOR A NUCLEAR REACTOR. Robert Gus Fischer (to General Dynamics Corp.). German Patent 1,178,188. Sept. 17, 1964. Priority date June 25, 1958, United States.

A gripper for the remote handling of a cylindrical radiation sample container, which is passed through the guide channel of a nuclear reactor, is described. The upper portion of the container above the upper end cap has the shape of a hollow cylinder provided with an inwardly protruding upper rim. The expandable and contractable arms of the gripper are dipped into the hollow cylinder to grip below the rim. The arms of the gripper are outwardly prestressed in such a way that the weight of the gripper suffices to pass the gripper arms through the opening of the hollow cylinder and to extend them afterwards into the gripping position. (Gmelin Inst.)

24027 DRIVE MECHANISM FOR CONTROL AND SAFETY RODS IN NUCLEAR REACTORS. Marc Alfred (to Commissariat a l'Energie Atomique). German Patent 1,181,333. Nov. 12, 1964. Priority date Feb. 5, 1960, France.

A nut and screw mechanism combined with bayonet coupling for holding the rod is described. It provides fine operation of the mechanism for normal operation of the reactor and provides rapid gravity operation for insertion of the rod into the core in case of danger. Two different electric motors are used, one for actuation of the screw and the other for actuating the bayonet coupling. (Gmelin Inst.)

Criticality Studies

See also PHYSICS — Criticality Studies.

Refer also to abstract 23616.

24028 (EUR-2273.e) KINETIC THEORY AND CALCULATIONS IN A FEW-ENERGY-GROUP TWO-SPACE-POINT MODEL FOR A FAST REACTOR PERIODICALLY PULSED BY REACTIVITY VARIATIONS. T. Asaoka and R. Misenta (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 37p. Dep.(mn).

A simple multigroup two-space-point kinetic theory has been developed in order to obtain accurately the characteristics of stationary pulses of a periodically pulsed fast reactor that contains water scatters in the reflector. The energy division aims at separating slow neutrons with lifetimes comparable to the pulse width (~50μsec) from fast neutrons. In addition to this, the space division is required to obtain especially the pulse characteristics of the thermal flux in the water scatterer. A comparison of the numerical results obtained from this two-space-point model with those of the one-point model shows that it is necessary to treat the core and scatterer separately, even for analyzing the pulse characteristics in the core. In addition, the calculation shows that an insulation of the core from intermediate as well as thermal neutrons produced in the scatterer is required, in order to obtain a high pulse amplitude in the fast group of the core and in the thermal group of the scatterer. (auth)

24029 (EUR-2285.e) ON A MULTIGROUP KINETICS. D. Schwalm (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1965. 49p. Dep.(mn).

For a pulsed fast reactor with H_2O scatterers the lifetime spectrum contains an appreciable component with lifetimes of the same order of magnitude as the pulse width. Thus, a one-group theory will give a mean lifetime which is not small compared to the reactivity pulse width, and it is therefore wrong to describe the kinetic behavior of the reactor with only one group. For this reason, a many-group method was carried out and applied to the SORA reactor. In particular, the problem of stationary pulses has been studied. (auth)

24030 (HW-83298(p.10,1-46)) PHYSICS. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

The sensitivities of the Plutonium Recycle Critical Facility (PRCF) to absorption and fission were measured using test cells Pu–Al rods. Design of the test cell is discussed along with reactivity results. Methods used in analyses of U-fueled light-water moderated critical experiments with uranyl nitrate are discussed along with analytical results. Results of Pu-light water critical experiments are also discussed. Activities directed toward problems associated with High Temperature Lattice Test Reactor design are summarized. Included are discussions of reactor calculation results, materials and prototype testing, time-of-flight spectrometer development, and lattice material oscillator development. Development of an approximate method for buckling in partially filled spheres is summarized, and application of the experimental system to critical experiments is discussed. Results of subcritical experiments and analytical correlations are described for PuO_2–UO_2 fuel rods moderated with water. (J.R.D.)

24031 (RPI-328-20(p.47-9)) UPSCATTERING FRACTION AND THE CHOICE OF THERMAL CUTOFF. P. B. Daitch and R. R. Lee (Rensselaer Polytechnic Inst., Troy, N. Y.).

Attempts to predict thermal spectra have led to reconsideration of the limit of cut energy (E_c) between the thermal and epi-thermal neutron groups in reactor analysis. To understand one of the factors connected with the choice of E_c an upscattering fraction is introduced and defined. Data are included on the fraction of events occurring below E_c which result in scattering to an energy above E_c. (J.R.D.)

24032 COMPUTER CODE FOR TWO DIMENSIONAL BURN-UP CALCULATIONS FOR LIGHT WATER MODERATED POWER REACTORS. Toshio Yoshioka and Tadashi Kagayama (Japan Atomic Power Co., Tokyo). Genshiryoku Kogyo, 10: No. 4, 49-52(Apr. 1964). (In Japanese)

The versatile burnup calculation code developed jointly by research institutes in Japan in the past few years is described. The code is divided into (part 1) computation of neutron spectrum and group constants (compiled by Hitachi, Ltd.), (part 2) two-dimensional few-group solutions of diffusion equations (by Nippon Atomic Industry Group), and (part 3) computation of concentration of different isotopes (by Mitsubishi Atomic Power Industries). In part 1, either of two methods can be used. In the first method Wigner-Wilkins equations and the transport equations are solved for thermal neutrons and fast neutrons, respectively. The second method is the modification of Deutsch's few-group constants calculations. In both cases, coefficients in diffusion equations, microscopic cross sections, and fitting coefficients for void are obtained for a given configuration and constitution of reactors. Part 2 receives the output of part 1 as its input and obtains either the neutron flux and void distribution for a given control-rod configuration or the rod configuration necessary for achieving a given flux distribution. Part 3 receives the microscopic cross sections from part 1 and flux and void distributions from part 2 as its input and calculates the variation in concentration of various isotopes as the burnup proceeds. (NSA of Japan)

24033 BOUNDARY CONDITIONS FOR A CYLINDRICAL ANNULAR REACTOR. S. Klarsfeld (SNECMA, Division Atomique, Suresnes and Centre National de la Recherche Scientifique, [Orsay, France]). J. Nucl. Energy, Pt. A & B, 19: 225-34(Apr. 1965). (In French)

An appropriate diffusion theory boundary condition at the inner surface of a cylindrical annular reactor is derived by equating the net rate at which neutrons enter the cavity from the sides to the rate at which they stream out through its ends. (auth)

24034 ABSOLUTE THERMAL-NEUTRON-FLUX MEASUREMENT USING VANADIUM FOILS. Edith B. Fehr and Donald H. Bryce (Cornell Univ., Ithaca, N. Y.). Nucleonics, 23: No. 3, 6-7, 38(Mar. 1965).

The merits of using vanadium foils for measurement of thermal-neutron fluxes are summarized, and a coincidence system for counting vanadium foils is briefly discussed, in which a proportional-flow counter and a scintillation counter were used for beta and gamma detection, respectively. (D.C.W.)

24035 A METHOD FOR SOLUTION OF THE ENERGY-DEPENDENT, ONE-DIMENSIONAL DIFFUSION EQUATION IN HETEROGENEOUS REACTORS. Helmut Kunze (Technische Hochschule, Karlsruhe, Ger.). Nukleonik, 7: 48-9 (Jan. 1965). (In German)

It was shown that the energy-dependent, one-dimensional diffusion equation for heterogeneous reactors with plate-shaped fuel elements can be solved exactly when the energy dependence of the flux was determined by a very good approximation described previously. This is an indication on the extensive applicability of this method to a more accurate determination of the site and energy behavior of the neutron flux in heterogeneous arrangements. (tr-auth)

24036 ROSSI-α THEORY FOR ASSEMBLIES WITH TWO PROMPT NEUTRON GROUPS. G. Kistner (EURATOM CCR, Ispra, Italy). Nukleonik, 7: 106-9(Feb. 1965).

Using the kinetics of an assembly, which is described by two prompt neutron groups besides the delayed groups, the time distribution of pairs of counts, caused by neutrons originating from common preceding fission processes, was derived. An expression with two exponentials was obtained. The application to results of measurements on Be-reflected fast assemblies (BRUNSON et al.) showed reasonable values for the constants and explains the observations. (auth)

24037 THE ABSOLUTE DETERMINATION OF NEUTRON FLUXES BY COINCIDENCE MEASUREMENTS. Jose O. Juliano (Philippine Atomic Research Center, Diliman, Quezon City). Philippine J. Sci., 93: 399-405 (Sept. 1964).

The determination of thermal-neutron fluxes by beta-gamma coincidence measurements on activated ^{197}Au foils was investigated by exposing two sets of Au foils (bare and Cd-covered) in the University of Virginia standard pile and counting the resulting ^{198}Au activity, using an anthracene crystal as the beta detector and an NaI(Tl) crystal as the photon detector. The results were found to agree with the quoted values for the standard pile, within the accuracy of the measurements and quoted values. (D.C.W.)

24038 REAKTORPHYSIK. ERSTER BAND. (Reactor Physics. Volume 1). Rudolf Schulten and Wernfried Gueth. B·I-Hochschultaschenbuecher. Band 6. Mannheim, Ger., Bibliographisches Institut, 1960. 175p. 3.80 DM.

The physical occurrences in a reactor under steady-state conditions are considered. Diffusion attenuation theory, perturbations of the homogeneity of the reactor core, the characteristics of the heterogeneous reactor, and the two-group theory are discussed. (J.S.R.)

24039 REAKTORPHYSIK. ZWEITER BAND. (Reactor Physics. Volume 2). Rudolf Schulten and Wernfried Gueth. B I-Hochschultaschenbuecher. Band 11. Mannheim, Ger., Bibliographisches Institut, 1962. 164p. 3.80 DM.

The representation of the time behavior of reactors, reactivity oscillations from poisoning, controlled problems, breeding, and corrosion behavior, and the thermal properties of reactors are considered. The mathematical fundamentals of reactor physics are compiled. (J.S.R.)

24040 VOID REACTIVITY MEASUREMENTS IN TWO REACTOR LATTICES OF UO_2 ROD CLUSTERS IN D_2O. F. W. A. Habermann. Thesis, Amsterdam, Free Univ., 1965. 79p.

For understanding the characteristics of a boiling water reactor measurements were carried out of various coolant void reactivity effects in the zero power facility NORA at room temperature and in the Halden BWR between 55°C and 220°C. The measurements in NORA were carried out with a core of 7-rod UO_2 cluster fuel elements of the HBWR. The shroud of one fuel element was subdivided in sections in which the water level could be depressed by air. The temperature dependence of the void effect has been determined by removing coolant from one UO_2 cluster fuel element in the HBWR. The coolant channel was voided to various depths by depressing the D_2O level in it by means of argon under pressure. (auth)

24041 SPATIALLY DEPENDENT TRANSFER FUNCTION FOR NUCLEAR SYSTEMS. Chester D. Kylstra and Robert E. Uhrig (Univ. of Florida, Gainesville). 42p. (CONF-654-69)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The concept of a transfer function for a nuclear system is extended to include spatial effects. The general equation is derived using the time-dependent Fermi age and diffusion theories for a single-region, isotropic, homogeneous medium. The fluctuations of the thermal neutron density at any point in the assembly is related to the variation of the fast neutron source. The general transfer function equation is specialized for several cases, including the case of a point source in a cylindrical medium. Theoretical curves are calculated for multiplying and non-multiplying media and are compared with the commonly used lumped parameter transfer function. The results indicate, in general, that

the lumped parameter model predicts the correct behavior of the nuclear system only if the output detector is carefully positioned at a specific distance from the source. If the detector is located elsewhere, the lumped parameter model is not capable of accurate results. The theoretical equations were used to calculate the spatially dependent transfer function between two detectors (the cross transfer function) that were located within light and heavy water subcritical assemblies, simulating some experimental measurements. A comparison of the experimental and theoretical transfer functions indicate that the Fermi age diffusion theory model might be quite adequate in describing the kinetics of a nuclear system. (auth)

24042 A NONLINEAR STUDY OF REACTORS WITH A LINEAR FEEDBACK. A. Ziya Akcasu and Larry D. Noble (Univ. of Michigan, Ann Arbor). 33p. (CONF-654-68)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Solutions of the point kinetic equations with delayed neutrons for reactor systems with arbitrary linear feedback are investigated. It is found that the solutions which are Laplace-transformable are bounded for all initial perturbations regardless of whether or not the system is linearly stable provided the Laplace transform of the feedback kernel has no zeros on the positive real axis. This criterion is applied to some reactor models previously investigated elsewhere. It is shown that there are also nontransformable solutions which possess a finite escape time and that such solutions can exist only if the reactor has a prompt positive reactivity coefficient. The asymptotic behavior of these solutions near the escape time is also obtained. These general conclusions are verified by considering some specific feedback models for which exact solutions are available. Numerical solutions for reactor systems with more realistic feedback models, such as one used to describe EBR-I, are obtained by a digital computer. (auth)

24043 TWENTY-SIX GROUP CROSS SECTIONS. D. M. O'Shea, H. H. Hummel, W. B. Loewenstein, and D. Okrent. 10p. (CONF-654-74)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The generation of a set of 26-group neutron cross sections for analysis of fast reactors is discussed. The evaluation of cross section data for individual inelastic level excitation, total inelastic cross sections, fission, nuclear temperature, and capture is outlined. Cross sections for both reactor fuel and structural materials are included. (D.C.W.)

24044 MEANS FOR IMPROVING THE NEUTRON FLUX DISTRIBUTION IN THE AXIAL DIRECTION OF A NUCLEAR REACTOR. (to European Atomic Energy Community). British Patent 980,943. Jan. 20, 1965. Priority date Aug. 31, 1962, Belgium.

In a nuclear reactor of the kind having a multiplicity of elongated fuel elements in parallel elongated channels, a more even distribution of thermal neutron flux in the direction of the channel length may be obtained by rendering devoid of fissile fuel some, but not all, of the fuel-containing channels on each side of a plane perpendicular to the length of the channels and intermediate in channel length. Alternatively the cross section of the fuel element in these channels may be reduced. Preferably the plane is the plane of symmetry of the reactor. (A.G.W.)

24045 METHOD OF LOCAL REDUCTION OF THE NEUTRON FLUX DENSITY IN A NUCLEAR REACTOR DURING THE EXCHANGE OF FUEL ELEMENTS. Constantin Syros (to Siemens-Schuckertwerke Aktiengesellschaft). German Patent 1,186,957. Feb. 11, 1965. Filed Dec. 12, 1962.

For the exchange of fuel elements disposed vertically one above the other in a vertical fuel element channel the upper end of the pillar from which a fuel element is lifted is surrounded by a socket of neutron absorbing material. A second socket is preferably lowered to the lower end of the next fuel element to be lifted and it is removed together with that fuel element. (Gmelin Inst.)

Design and Feasibility

24046 PRELIMINARY DESIGN OF 100-KILOWATT(E) THERMIONIC CONVERSION REACTOR CORE. Frank Russo (Martin Co., Baltimore). 18p. (CONF-64-219-56)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

A preliminary design has been obtained for a reactor core employing thermionic diodes for direct conversion of power. From a parametric study of power flattening and reactivity, it was shown that a variation of slowing down spectrum through moderator distribution and reflector composition could provide a power distribution that was sufficiently uniform. An effective peak-to-minimum diode power of 1.10 was obtained. A 17-group transport theory calculation was the principal analytic technique. Multigroup cell calculations were made with a high order approximation solution and the disadvantage factors were applied to lower order (equivalent to diffusion theory) solutions of homogenized radial and axial problems. A six-group two-dimensional (R-Z) calculation was used to provide more precise determination of power distribution and reactivity of the core configuration. The radial and axial studies suggested that a minimum size core could be obtained by using an increasing element spacing in the radial direction while increasing the moderator (hydrogen) density in the axial direction. Thus, the volume fraction of the moderator, yttrium hydride, is varied radially and the hydriding condition is varied axially. Since the reflector can influence power distribution and reactivity considerably for the 20-inch diameter core size anticipated, a separate study of reflector composition and thickness was made using a fixed core configuration. A moderating reflector such as BeO or a mixture of nonmoderating and moderating materials (alumina and yttrium hydride) was found to flatten the power significantly by neutron spectrum modification while providing neutron reflection for high reactivity worth. On the bases of these studies, a preliminary design core configuration was selected for detailed, two-dimensional analysis. It contained three radial spacings of fuel elements (diodes) and equal sized regions axially (from the core midplane) of varying hydrogen density. The core characteristics are summarized including the results of the two-dimensional calculation. (auth)

24047 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stanley Hackney (to United Kingdom Atomic Energy Authority). British Patent 981,423. Jan. 27, 1965. Filed June 9, 1960.

The nuclear reactor described has water as a reactor coolant medium, a heat-producing core of fuel elements, and a fluid heat transfer medium present as an intermediary between the fuel elements and the coolant medium. The fluid heat transfer medium is contained in a circuit separate from, in heat transfer relationship with, and everywhere surrounded by the reactor coolant medium. Preferably a pump is provided to circulate the heat transfer medium under pressure. Contamination of the coolant medium is prevented by this means and the hazard caused by a breach in the coolant circuit is reduced. (A.G.W.)

24048 IMPROVEMENTS IN OR RELATING TO HETEROGENEOUS NUCLEAR REACTORS. Stanley Hackney (to United Kingdom Atomic Energy Authority). British Patent 981,424. Jan. 27, 1965. Filed July 15, 1960.

The core of the nuclear reactor described is arranged to superheat steam separated from the water reactor coolant. The reactor core assembly consists of pairs of tubes adapted to contain sheathed fuel elements disposed in a heat transfer fluid. The tubes are interconnected so that the heat transfer fluid, in relation to a cooling fluid passed over the tubes, proceeds first in one tube in a similar direction to the coolant and then in the other tube in an opposite direction. The tubes are so constructed that heat transfer is reduced where the fluids are flowing in similar directions and increased where the fluids are flowing in opposite directions. Steam separated from the coolant passes over the tubes with greater heat transfer and is superheated to a degree as near as possible to the

maximum temperature attained by the pressurized water used as heat transfer medium. (A.G.W.)

24049 NUCLEAR REACTOR. Stanley Hackney (to United Kingdom Atomic Energy Authority). British Patent 981,425. Jan. 27, 1965. Filed Sept. 19, 1962.

The nuclear reactor described has a core of fuel elements, a coolant, and a heat transfer medium contained between the fuel elements and the coolant. The circuit for the heat transfer fluid has a riser section containing fuel elements and a downcomer section to return the fluid from the top to the bottom of the riser section. The downcomer section is arranged to be cooler over its whole length than the riser section so as to promote natural convection circulation of the heat transfer fluid and thereby dispense with forced circulation. The pressure of the heat transfer liquid is controllable to permit a slight degree of boiling so that turbulence is promoted in the liquid by the vapor bubbles. (A.G.W.)

24050 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stanley Hackney (to United Kingdom Atomic Energy Authority). British Patent 981,426. Jan. 27, 1965. Filed June 9, 1960.

The nuclear reactor described has water as a reactor coolant medium, a heat-producing core of fuel elements, and a heat transfer medium interposed as a layer between the fuel elements and the coolant. The heat transfer medium is a liquid moderator everywhere separate from the reactor coolant and pressurized to prevent boiling in the region of the fuel elements. The heat transfer medium may be water of the same type as the coolant or it may contain reactivity-controlling additions in variable amounts. (A.G.W.)

24051 NUCLEAR REACTOR WITH A PLURALITY OF FUEL ELEMENTS. Andre Huet. German Patent 1,181,332. Nov. 12, 1964. Priority date Jan. 7, 1958, France.

A heterogeneous core is described, which consists of a plurality of upright, equally shaped, cylindrical pressure vessels each of which encloses a plurality of fuel elements and through each of which the reactor cooling medium is circulated. The pressure vessels communicate with one another via horizontal pipe connections several of which are provided for each vessel. (Gmelin Inst.)

24052 NUCLEAR REACTOR. C. W. Wheelock (to U. S. Atomic Energy Commission). U. S. Patent 3,178,356. Apr. 13, 1965.

An organic cooled and moderated reactor was designed. A simplified reactor core is provided with the core aligned and mounted from a single bottom head flange. There is no top grid plate. The fuel elements are supported on removable and replaceable lower sectional grids, which keep the fuel elements aligned in parallel relationship. (AEC)

24053 HEAVY WATER MODERATED ORGANIC-COOLED NUCLEAR FISSION REACTOR. R. J. Rickert, W. S. Flinn, J. R. Rohlin, and J. J. Roth (to U. S. Atomic Energy Commission). U. S. Patent 3,180,801. Apr. 27, 1965.

A heavy water-moderated, organic-liquid-cooled nuclear fission reactor, with programmed refueling during reactor operation to minimize the reactivity requirement, is described. The core of the reactor is designed to permit biaxial refueling so that in each fuel channel there is a full range of fuel burnup, from fresh fuel at one end to full burnup at the opposite end, with adjacent fuel channels being oppositely arranged. In refueling, the fuel with maximum burnup is pushed out from the opposite end where fresh fuel is inserted. (AEC)

Fuels

Refer also to abstracts 22427, 22480, 22866, 22870, 22920, and 23624.

24054 (IDO-14654) MEASUREMENT OF FISSION-PRODUCT LEAKAGE FROM FUEL ELEMENTS STORED IN WATER. D. W. Rhodes (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Mar. 1965. Contract AT(10-1)-205. 9p. Dep.; $1.00(cy), 1(mn) CFSTI.

A method for detecting cladding defects in fuel elements stored underwater by measuring the rate of increase in the concentration of radioisotopes in the water is described. The only special equipment needed is a stainless steel container with compressed air and water connections and conventional beta counting equipment. The method can be used for any type of solid fuel that is suitable for underwater storage. (auth)

24055 HEAT TRANSFER AND PRESSURE DROP OF A REACTOR FUEL ELEMENT MODEL WITH POLYZONAL SPIRAL FINNING. S. Oka and S. Becirspahic. Bull. Boris Kidrich Inst. Nucl. Sci., 15: 227-46(Oct. 1964).

The heat transfer and pressure drop of a reactor fuel element model with polyzonal spiral finning were investigated. The St-number distribution over the length and perimeter of the finning are given. The mean and minimum St_k-number are plotted against the Re-number. The influence of the gap between two fuel elements upon heat transfer and pressure drop, in dependence on the Re-number, and the influence of the length of the fuel element on pressure drop across the gap are shown. The influence of the relative position of the splitters of two neighboring fuel elements on pressure drop and heat transfer is shown. The investigations were performed in the Re-number range from 15,000 to 100,000. (auth)

24056 A PHENOMENOLOGICAL MODEL OF THERMALIZATION IN CLUSTER FUEL ELEMENTS. A. Kind and G. Rossi (CCR, Euratom, Ispra, Italy). J. Nucl. Energy, Pt. A & B, 19: 217-24(Apr. 1965).

A simplified model to evaluate the neutron spectrum in cluster fuel elements, which was previously concerned with "thermal" effects, was extended to take into account the epithermal ones. This was done on the basis of a simple separation of the "homogeneous" spectrum effects, which have been evaluated by means of a preliminary homogenization of the cell. On the basic homogeneous spectrum obtained in this way the heterogeneity effects characteristic of the fuel element (rethermalization and geometrical hardening)—separately evaluated—were applied. The difficulties connected with the introduction of the interference effects between hardening and rethermalization are discussed and a comparison with the reaction-rate ratios measured at Chalk River is presented. (auth)

24057 EXPERIENCE WITH BWR FUEL RODS OPERATING ABOVE CRITICAL HEAT FLUX. T. Sorlie, S. Levy, M. F. Lyons, and J. E. Boyden (General Electric Co., San Jose, Calif.). Nucleonics, 23: No. 4, 62-5; 88 (Apr. 1965).

An experiment performed on Zircaloy-2 and 304 stainless steel clad fuel rods in the boiling water loop of the General Electric Test Reactor is described, which shows that short-term operation above the critical heat flux will not necessarily cause failure unless the temperature exceeds the melting point of the cladding material. Critical heat flux criteria for boiling water design are formulated. (L.B.S.)

24058 EVALUATION OF PLUTONIUM COMPOUNDS AS REACTOR FUELS. Nucleonics, 23: No. 4, 72(Apr. 1965).

On the basis of an evaluation of plutonium compounds at Batelle for use as fast and thermal reactor fuels and isotopic power sources, the following compounds are considered to be the most promising: PuN, PuO_2, PuC, PuS, PuP, $PuAl_2$, $PuSi_2$, PuAs, PuTe, and PuB. (L.B.S.)

24059 IMPROVEMENTS RELATING TO FUEL ELEMENT CANS FOR NUCLEAR REACTORS. Carlo Della Rocca, Laurence Charles Ward Dixon, and John Richard Ward (to English Electric Co., Ltd.). British Patent 980,741. Jan. 20, 1965. Filed May 27, 1960.

The fuel element cans described have a finned heat transfer surface divided into separate zones by generally lengthwise extending flow splitters of greater radial depth than the fins. The splitters are arranged asymmetrically so that, with the can in position in the fuel channel and with coolant flowing, a net transverse component of force is applied to the can by the coolant to stabilize the can in the fuel channel. (A.G.W.)

24060 IMPROVEMENTS RELATING TO FUEL ELEMENT CANS FOR NUCLEAR REACTORS. Maurice Roy Slack, John Dawtrey Wallis, and Allan James Williams (to English Electric Co., Ltd.). British Patent 980,742. Jan. 20, 1965. Filed May 27, 1960.

The fuel element cans described have a finned heat transfer surface divided into separate zones by generally lengthwise extending splitters having a greater radial depth than the fins. Each flow splitter is provided with at least one lengthwise extending strengthening rib or flange. (A.G.W.)

24061 NUCLEAR FUEL ELEMENT AND METHOD OF PRODUCTION. Jacques Andre Stohr and Maurice Gautron (to Commissariat a l'Energie Atomique). German Patent 1,178,151. Sept. 17, 1964. Priority date Aug. 21, 1958, France.

A cylindrical fuel element is described, which consists of stacked cylindrical fuel rings enclosed in a close-fitting metallic sheath. These fuel rings are either equally shaped or they have different wall sizes and/or different outer diameters. The rings or groups of rings may be held in spaced relationship by the profiled sheath. (Gmelin Inst.)

24062 FUEL ELEMENT FOR PREFERENTIALLY GAS- OR METAL-COOLED NUCLEAR REACTORS. Karl Heinz Hoecker (Siemens-Schuckertwerke Aktiengesellschaft). German Patent 1,182,362. Nov. 26, 1964. Filed July 12, 1958.

The fuel element consists of unsheathed fuel rods arranged in parallel with the ends of the rods stuck in graphite cylinders. These elements are stacked in a closed tube filled with a rare gas and provided with horizontal holding bodies into the recesses of which the graphite cylinders are fitted. These tubes are concentrically arranged in the tubes of the cooling channels so that an annular space is present between the tubes through which the cooling medium is circulated. (Gmelin Inst.)

Power and Power-Breeder Reactors

Refer also to abstracts 23355 and 24017.

24063 (ACNP-64611) ELK RIVER REACTOR OPERATIONS ANALYSIS PROGRAM. Annual Progress Report, July 1, 1963–June 30, 1964. M. N. Audi, J. R. Fisher, C. Ho, E. D. Kendrick, T. P. Kruzic, and A. C. Schafer, Jr. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Contract AT(11-1)-1357. 92p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

During the report period, integrated operation of the reactor plant was achieved at power levels up to 58.2 Mwt. Initial production of electrical power from the nuclear plant was achieved on August 24, 1963. During power escalation from 5 to 8.8 Mwe, an irregularity in feedwater flow was observed in Loop No. 1. The cause of this irregularity was found to be hydraulic, and corrective actions were taken. Activity in the off-gas system, caused by tramp U on the fuel elements, was a source of operating difficulty which led to operation of the reactor in the "non-vented" condition. With the exception of the aforementioned problems, operation of the plant was satisfactory. The operations analysis has progressed in accordance with the work schedule. Data taken during reactor operation were used in determination of core nuclear characteristics and in areas of core management. Topical reports were written to describe the determination of the fuel loading for the second core and to describe the control rod analysis. A summary of the work covered in the topical reports is included. Operating data were also used to provide a reference for comparing and evaluating the performance of the plant systems. The performance of these systems has agreed generally with the design parameters. The results of heat balance calculations and overall heat transfer coefficients are included. A study of the long-term-decontamination and waste-disposal requirements, cask handling, and storage and control rod disposition was started. Significant changes in the plant equipment during the report period are described. The Elk River Reactor (ERR) operations analysis program technically analyzes and evaluates plant performance in support of the primary objective of the reactor plant, which is to demonstrate a high plant availability factor, consistent with concurrent objectives of low-cost power generation and safe operation. (auth)

24064 (ANL-6997) REACTOR DEVELOPMENT PROGRAM. Progress Report, December 1964. (Argonne National Lab., Ill.). Jan. 18, 1965. Contract W-31-109-eng-38. 70p. Dep.; $3.00(CFSTI).

Research and development are reported on fast reactor physics and concepts, fast reactor fuels, fuel reprocessing, EBR II, FARET, experimental and theoretical reactor physics, fuels and materials testing, remote-control engineering development, heat engineering, chemical separations, plutonium recycling, Argonne Advanced Research Reactor, magnetohydrodynamics, regenerative emb cells, thermal reactor safety, fast reactor safety, and TREAT. (J.R.D.)

24065 (AFWL-TDR-64-81) AIR TRANSPORTABILITY OF REACTOR AND RADIOISOTOPE MATERIALS. James Fox (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Aug. 1964. 258p. (AD-606056). $6.00(CFSTI).

A study was made to investigate the prime considerations involved in air transportation of nuclear reactor components, radioactive wastes, and radioisotope power-generating units. The logistics, economics, and safety of supplying a remote military nuclear power plant by air, and of transporting SNAP-type reactor and radioisotope auxiliary power units by USAF aircraft are explored in detail. It was determined that such air transport operations are feasible and reasonably safe if proper planning is accomplished in the design of equipment and in the definition of mission profiles and ground handling procedures. Container criteria and procedural standards for the transport of the different categories of materiel are recommended. (auth)

24066 (CEA-R-2554) ETUDES PRELIMINAIRES CONDUISANT A UN CONCEPT DE REACTEUR A NEUTRONS RAPIDES DE 1000 Mwe. (Preliminary Studies Leading to a Conceptual Design of a 1000-Mwe Fast Neutron Reactor). G. Vendryes, C. P. Zaleski, R. Abdon, et al. (Commissariat à l'Énergie Atomique, Cadarache (France). Centre d'Études Nucléaires). 1964. 129p. (EUR-2235.f). Dep.(mn).

Studies are described in connection with the development of fast reactors. The advantage of high internal breeding ratios (~1.1), which are necessary in order to get a small change in time both in power distribution and reactivity (less than 0.005 $\Delta k/k$ in 18 months), are noted. Means are described to achieve this goal, when simultaneously power distribution flattening is obtained. These result in high mean specific power (which is an economic gain) and therefore in a small doubling time (about 10 years). Criteria are sought for the specific power that should be used in future reactor designs. A conceptual design of a 1000-Mwe fast neutron reactor, for the realization of which no technological impossibility appears, is presented. The dynamic behavior seems satisfactory, despite a positive total isothermal sodium coefficient. The development of fast reactors within the future total nuclear program is discussed. It does not appear that fissile materials supply problems should slow down the development of French fast reactors, which will be essentially tied up to its economical ability to produce cheap electric power. (auth)

24067 (CEA-R-2556) ETUDES PRELIMINAIRES DE MANUTENTION DANS LES REACTEURS A NEUTRONS RAPIDES DE GRANDE TAILLE. (Preliminary [Fuel] Handling Studies in Fast Reactors of Large Size). Jean Leduc and Pierre Marmonier (Commissariat à l'Énergie Atomique, Cadarache (France). Centre d'Études Nucléaires). June 1964. 35p. (EUR-2231.f). Dep.(mn).

Various fuel handling systems that seem feasible for a

fast power reactor are examined. The advantages and/or disadvantages, and the fabrication problems for each solution involved are discussed. The time required for a fuel loading and/or unloading operation is estimated. The influence of the maximum allowable burnup, the number of shutdowns, and the power distribution shape within the core on the storage capacity needed is investigated, as well as the load factor expected and the average burnup obtained. (auth)

24068 (CONF-640607(Vol.I)(Paper A-9)) [IN-CORE INSTRUMENTATION IN ITALY]. S. Moretti (Comitato Nazionale per l'Energia Nucleare, [Ispra] (Italy)). 4p.

Development of instrumentation for the Italian reactors Latina, Garigliano, and Trino Vercellese is outlined. (T.F.H.)

24069 (CONF-640607(Vol.I)(Paper B-4)) GARIGLIANO B.W.R. IN-CORE FLUX MONITORING SYSTEM BEHAVIOUR DURING THE FIRST PERIOD OF POWER OPERATION. Guido Foti (Societa Elettronucleare Nazionale, Rome (Italy)). 12p.

The Garigliano Power Reactor contains 80 fission-chamber neutron detectors distributed within the core. The readout, uses, scramming characteristics, and calculational value of the detectors and their data are outlined. The detectors themselves, along with their electronics, are described. The testing, behavior, and operations of the system of detectors are reviewed. (T.F.H.)

24070 (CONF-640607(Vol.I)(Paper C-1)) THE FLUX MAPPING SYSTEM OF THE SELNI PLANT. Fortunato Cioli (Societa Elettronucleare Italiana, Milan (Italy)). 12p.

A flux-mapping system for reactors is described, in which columns of spheres are irradiated in tubes. After a predetermined irradiation time, the spheres are blown out of the reactor core by air pressure, and the induced activity in the spheres is determined by a gamma counter. In the SELNI power reactor at Trino, Italy, which uses this type of flux-mapping system, 30 columns of spheres are distributed throughout the core. (T.F.H.)

24071 (CONF-640607(Vol.II)(Paper D-8)) THE IMPEDANCE VOID METER. I. Oerbeck (Institutt for Atomenergi, Kjeller (Norway)). 51p.

The steam void gage is described that was primarily developed as part of the in-core instrumentation in the Halden Boiling Water Reactor for the measurement of transient voidage in the transfer function experiments. The technique of measurement described is based upon the principle that the impedance between two plates immersed in a two phase fluid is the vector sum of the resistive (R) and reactive ($1/\omega c$) components. Partial replacement of the liquid by vapor will increase R and ($1/\omega c$) in the same proportion so that the phase angle remains unchanged and the sum gives a measure of the void content. At 230°C the impedance of the D_2O in the HBWR reactor consists mainly of the resistive component, the d-c resistance with 0 void being about 600 Ω and the capacitive reactance several thousand ohms, including cabling. The absolute value of the impedance at zero void fraction depends upon the resistivity of the water. If the resistivity remains unchanged during a series of measurements, the percentage change in impedance for a given void fraction will be independent of the actual value of resistivity, as has been confirmed experimentally. The gage reading can be zero-set by a sensitivity control either from the reading at zero void fraction or from that of an identical gage in the single-phase region at the inlet of the channel. The conductivity is less dependent on a temperature change at 150 to 250°C, which will be the operating range of the gage, than on temperature changes at lower temperatures. (auth)

24072 (CONF-640607(Vol.II)(Paper F-2)) FUEL FAILURE LOCATION IN NATURAL-CIRCULATION BOILING WATER REACTORS BY STEAM SAMPLING OR LOCAL FLUX DEPRESSION. J. G. Siverts (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). 29p.

The HBWR has been equipped with a bulk monitor that continuously samples coolant from the purification loop. The system has worked satisfactorily. An experimental program aimed at development of a more reliable failed-element locating system or method was initiated. (auth)

24073 (CONF-640607(Vol.II)(Paper G-1)) IN-CORE INSTRUMENTS USED FOR START-UP EXPERIMENTS IN AGESTA POWER REACTOR. Pehr E. Blomberg (Aktiebolaget Atomenergi, Stockholm (Sweden)). 3p.

Instrumentation used during startup of Agesta reactor for measurement of critical water levels, reactivity coefficients, control rod worths, flux distributions, fine structures in the fuel elements, fuel burnup, and reactor dynamics is described. (T.F.H.)

24074 (CVNA-225) CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC., RESEARCH AND DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT, APRIL–JUNE 1964. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-2289. 57p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

The response of the reactor to step and ramp load changes was determined by tests with and without automatic control. Data obtained in these tests are included. Post-construction steady-state operating data from the CVTR were compared with design criteria data. Results of this study indicate that the major thermal and hydraulic parameters are within the design limits and the core is judged to be capable of continuous steady-state operation at 44.3 Mw(t). A plant nuclear evaluation is presented which includes an analysis of low-power flux-wire data. (J.R.D.)

24075 (DPST-65-83-2) USAEC-AECL COOPERATIVE PROGRAM MONTHLY PROGRESS REPORT, FEBRUARY 1965. H. S. Hilborn, comp. (Du Pont de Nemours (E. I.) & Co., Aiken, S. C. Savannah River Lab.). Mar. 15, 1965. Contract AT(07-2)-1. 12p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Two papers are included on the effect of rod spacing on heat transfer burnout and hydride orientation and mechanical properties of thin-walled zircaloy tubing. Separate abstracts are prepared for each paper. (C.E.S.)

For abstracts of individual papers see: 22479 and 22970.

24076 (GA-4966) ADVANCED BERYLLIUM OXIDE CONCEPTS. Progress Report, October 1–December 31, 1963. (General Atomic, San Diego, Calif.). Jan. 29, 1964. Contract AT(04-3)-187. 69p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Progress is reported in the engineering and physics studies of $BeO-ThO_2-UO_2$ and $BeO-PuO_2-ThO_2$ fuel bodies for the Advanced Beryllium Oxide Concepts program. (W.L.G.)

24077 (GA-6134) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR. POST CONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for Period Ending January 31, 1965. (General Atomic, San Diego, Calif.). Feb. 26, 1965. Contract AT(04-3)-314. 10p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Calculations made to predict power distributions in core configurations which may be measured in the course of the reactor experimental program are described. Zero-power tests in unrodded cores are discussed along with power distribution measurement with control rods. The testing and development status of instrumentation required for the performance of the startup and postconstruction research and development is summarized. (J.R.D.)

24078 (GA-4710) ADVANCED BERYLLIUM OXIDE CONCEPTS. Progress Report for the Period July 1–September 30, 1963. (General Atomic, San Diego, Calif.). Nov. 15, 1963. Contract AT(04-3)-187. 58p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Preliminary engineering designs for power reactors utilizing graphite-clad UO_2-ThO_2 fuel elements with helium cooling and Hastelloy-clad PuO_2-BeO fuel elements with carbon dioxide cooling are described. The influences of the coolant pressure and fuel-element surface roughening on reactor performance were studied for PuO_2-BeO fuel

elements. The performance and economics of using feed fuel mixtures of 90% ^{233}U and 10% ^{235}U or 100% ^{235}U and of using graphite, BeO, and BeO/Hastelloy sleeve materials were examined. A four-cell fuel capsule was designed for the study of fission-gas release from EBOR-type UO_2–ThO_2–BeO fuel materials during irradiation. Information regarding the fission-product-release rate, the effect of fuel agglomerate size on the release rate, and the effect of irradiation on the dimensions and physical properties of the fuel materials is expected to be obtained. Calculations to specify a plutonium-fueled test element for inclusion in future EBOR experiments were completed. These calculations include a re-evaluation of lifetime studies of different diameter cores with revised ^{240}Pu neutron cross sections; reactivity worth of Hastelloy cladding and lifetime as a function of cladding thickness; a comparison of BeO and hydrogen moderators when used with plutonium fuel; the effects of plutonium fuel grain size on the ^{240}Pu resonance-capture rate and reactivity-lifetime characteristics; and the buildup of curium isotopes in the plutonium fueled core. Calculations were made examining the feasibility of using plutonium as a feed material in uranium-thorium-fueled, BeO-moderated reactors. (W.L.G.)

24079 (GA-5487) ADVANCED BERYLLIUM OXIDE CONCEPTS. Progress Report for the Quarter Ending June 30, 1964. (General Atomic, San Diego, Calif.). Aug. 1, 1964. Contract AT(04-3)-187. 40p. Dep.(mn); $2.00(cy), 2(mn) CFSTI.

The design of a fuel element using a cylindrical matrix in which holes of varying number and shape have been formed and then filled with a fueled material such as UO_2 and ThO_2 mixed with BeO is considered. For small ratios of thermal conductivities of fuel and fertile material to those of the matrix material, studies show that the more finely the fuel body is subdivided into small sections within the solid fuel element, the lower the maximum fuel temperature becomes for a fixed power output from the element. Calculations performed on a cylindrical graphite element cooled both internally and externally and having a fueled inner spine indicate its possible use as a high-power-density element. The sintering properties of GC- and UOX-grade BeO, with and without flux additions or ball-milling, are studied. Comparison of extruded or vapor-deposited silicon carbide tubes, for possible use as sleeve material, show that the vapor-deposited silicon carbide has the better dimensional tolerances, high density, and low permeability. An investigation was made to determine the effect of a gap between the fuel body and graphite sleeve on the thermal performance of the BeO–ThO_2–UO_2 test module. The gap is necessary as the fuel compact expands appreciably during its lifetime and the allowable power density is sensitive to the gap width. The possible damage caused by the oxidation of the graphite sleeve during emergency air-cooling of EBOR was investigated. The analysis indicated that the heat flow from the burning element did not result in dangerously high temperatures or temperature gradients in the adjacent EBOR elements. (W.L.G.)

24080 (GEAP-4759) EVESR-NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT. Quarterly Report No. 10, September–November 1964. J. L. Murray (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Dec. 1964. Contract AT(04-3)-189. 163p. Dep.(mn); $5.00(cy), 4(mn) CFSTI.

The reactor operating performance was excellent during the period August 28 to November 8, 1964, at which time the reactor was shut down for a major plant outage. Major items scheduled to be completed during the shutdown include interconnection of the turbine generator, modification of main steam isolation valves, installation of four Mark III fuel bundles and two specially instrumented Mark II fuel bundles, and provision for increasing EVESR reactor power to 17 Mw(t). A 293 Mwd/t exposure was accumulated to provide an average core exposure for Mark II fuel of 708 Mwd/t. The time operated efficiency during the period was 66%. Critical path planning methods were utilized for the EVESR outage. The startup test program is planned for early January and operation at full power for early February 1965. Assembly, acceptance testing, and installation in the reactor were completed for the four Mark III fuel elements during the period. No unusual difficulties were encountered in the removal of the Mark II fuel elements, and based on observations to date, the fuel has not lost cladding integrity. Planning is now under way for minimal in-pool post-irradiation examinations. Mark IV fuel element and bundle designs are near completion, and fabrication was initiated. Injection of H_2 and O_2 into the saturated steam supply was initiated; the O_2-H_2 analyzer performed satisfactorily in service. Preparations are being made to install the corrosion autoclave and portions of the fuel pool demineralizer system during the reactor outage. Chloride levels in EVESR were maintained below 1 ppB while reactor was operating. The EVESR fission gas release rate at 12.5 Mw(t) was less than 2 μC/sec except on September 30 when the level was measured at 6 μC/sec. (J.R.D.)

24081 (GNEC-361) ADVANCED BONUS CORE DEVELOPMENT PROGRAM. Quarterly Progress Report No. 3, May–July 1964. John F. Gibbons, Ray L. Lyerly, William A. Maxwell, and K. E. Roach (General Nuclear Engineering Corp., Dunedin, Fla.). Aug. 15, 1964. Contract AT(40-1)-3154. 228p. Dep.(mn); $6.00(cy), 5(mn) CFSTI.

Work during the period was directed toward bringing the design and experimental and manufacturing development to a sufficiently advanced stage to permit selection of an advanced Bonus core fuel element for irradiation and thermal cycling tests. Thermal and nuclear evaluations were made of annular and small solid multitube fuel elements. The small solid element selected for comparison has 7 steam tubes of Inconel 800 or 625 with Zircaloy-2 cladding on the boiler side. Results of studies indicate that the objective of reduced power costs in Bonus can best be achieved with the small solid element. Multitube fuel element tests were continued in EVESR. Other reactor material and component tests are summarized along with fabrication process development. (J.R.D.)

24082 (HW-75728) THERMAL HYDRAULIC ANALYSIS OF PRTR FUEL ELEMENTS AT 1800 kw TUBE POWER. G. M. Hesson and J. M. Batch (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 3, 1962. Contract AT(45-1)-1350. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A reexamination of the thermal hydraulic analysis of the PRTR and its fuel elements was made and included consideration of additional information from laboratory experiments. From the results, a boiling burnout safety factor of 1.85 is recommended for normal operation of the reactor with a fuel loading of 19-rod Mark I elements. Both the Mk-I and Mk-II-c fuel elements can be operated safely in the PRTR at a tube power of 1800 kw with an inlet water temperature of 443°F. At 1800 kw the boiling burnout heat flux for a properly centered non-warped fuel element would be about 4.2 times the equilibrium actual heat flux. The closest approach to boiling burnout would occur at a location approximately two feet from the downstream end of either fuel element. Hydraulic instability would not be expected to be a problem with either fuel element operation at a tube power of 1800 kw. The ability of the flow monitor to detect small leaks at the entrance of a coolant tube was better than shown previously. (P.C.H.)

24083 (HW-83298(p.3.1-10)) ANALYTICAL STUDIES AND ADVANCED CONCEPTS. (General Electric Co., Richland Wash. Hanford Atomic Products Operation).

The VESTA program was revised to allow simultaneous considerations of seven reactor types. ALTHAEA coding was completed to Compute Doppler broadening of the shielded resonances. Two new cores for the Segmented Fast Reactor (SFR) were selected for nuclear analysis. Data on these 1000-Mwe cores are included. Results of analyses on nuclear safety of mixed oxides fuel in fast reactors indicate that large positive reactivity increments can result from collapse of the oxide inside the cladding during reactor excursions. In coolant evaluation studies it was concluded that D_2O provides a saving of 0.1 to 0.2

mill/kw-hr in fuel cycle costs as compared with H_2O. Construction of the High Temperature Lattice Test Reactor Mockup is complete. Equilibrium and kinetic studies of H_2-Zr systems were started. (J.R.D.)

24084 (HW-83298(p.6.1-14)) GAS-COOLED REACTOR STUDIES. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

An exposure unit for use in radiation damage experiments is discussed. The exposure unit is equal to the integrated flux above a chosen energy, which is specified by the condition that the integrated flux above this energy be proportional to gross displacement production for the spectra under consideration. Results of experiments indicate that when data were normalized by conventional methods without considering the spectra, a 50% difference was observed between data from graphite-moderated reactors and those from light water-moderated reactors. Tests results indicate that furfuryl-alcohol impregnation of graphite is a necessary step in the manufacture of graphite components for reactors. Progress in long-term irradiation of EGCR graphite is reported. (J.R.D.)

24085 (HW-83298(p.11.1-11)) PLUTONIUM RECYCLE TEST REACTOR OPERATION AND RELATED FUNCTIONS. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation).

Operation of PRTR is summarized along with work on design analysis and testing for PRTR. Work at the Plutonium Recycle Critical Facility (PRCF) included PRCF-EBWR fuel studies. PRTR support activities included PRCF-EBWR safety studies, evaluation of PRTR loop use in boiling burnout tests, studies of PRTR power increase, testing of PRTR tube-nozzle gaskets, development of PRTR calandria tube replacement mockup, and PRTR fretting corrosion studies. The effectiveness of oxalic acid solutions and EDTA-based solutions were evaluated for dissolution of PuO_2. Other studies were conducted on chemical shim for PRTR moderators, Al corrosion and alloy development, critical flow in steam-water mixtures at high temperatures and pressures, and upstream boiling burnout. Results of experiments to determine the difference in boiling burnout heat fluxes of 19-rod bundle fuel elements operated in vertical and horizontal position are included. (J.R.D.)

24086 (JPL-TR-32-685) THE TWO-REGION FISSION-ELECTRIC CELL REACTOR. Jerome L. Shapiro (Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena). Feb. 15, 1965. Contract NAS 7-100. 10p.

A modification of the fission-electric cell reactor is examined from the standpoint of reactor physics. This modification involves the insertion of a non-power-producing region, in order to maintain nuclear criticality. The goal is to increase the over-all efficiency by permitting thinner fuel layers in the electric-cell region. A simplified, highly idealized model is utilized to make rapid calculations of a survey nature. This model uses age-diffusion theory for the neutron transport. It also assumes that the added region is vanishingly thin, and is both an absorber of thermal neutrons and a source of fast neutrons. Then a multi-group, multi-region model is employed to check the accuracy of the simple model, and to give detailed power distribution data for one design problem. Applied to a small (5-ft diam.) beryllium-moderated reactor, this calculational technique indicates that significant increases in over-all efficiency are achievable in the two-region reactor. (auth)

24087 (NAA-SR-Memo-10529) PREPARATION AND TRANSPORTATION OF PIQUA FUEL ELEMENTS. Summary Report. K. E. Neff (Atomics International, Canoga Park, Calif.). Oct. 12, 1964. Contract [AT(11-1)-Gen-8]. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The relative merits of factory and field assembly of the Piqua fuel elements were evaluated, and factory assembly was selected as the more desirable. However, due to their configuration, it was judged probable that the final elements would sustain damage if shipped assembled to the PNPF site without special provisions. A procedure was then developed, wherein the fuel elements were filled with diphenyl to prevent relative movement of the fuel element parts, thus inhibiting damage in transit. Special shipping containers, a soft-ride vehicle, and instrumentation for monitoring the shipments were provided. Following a successful test of the procedure and equipment, the 120 initial Piqua fuel elements were delivered to the PNPF site. (auth)

24088 (SRO-112) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, JANUARY 1965. (Savannah River Operations Office (AEC), Aiken, S. C.) 6p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Data obtained in the Du Pont fog-cooled Star Test section on burnout are presented. Observations from experiments on orientation ZRH platelets are discussed. Information is included on plans for evaluation of Nb–Zr pressure tubes, in-reactor creep tests on Zircaloy-2 and Nb–Zr alloys, and fabrication of U–Pu fuel assemblies. Work toward placing HWCTR in standby status is reported. An operation summary for the Carolinas-Virginia Tube Reactor is included. (J.R.D.)

24089 (SRO-114) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, MARCH 1965. (Savannah River Operations Office (AEC), Aiken, S. C.). 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Research and development on the heavy-water organic-cooled reactor (HWOCR) program are summarized. Developments are reported on fuel channel assemblies, fuel elements, reactor materials, reactor physics analysis methods, and reference designs. Work on Th fuel cycle development was devoted to analytical methods, fuel elements, fuel cycles, reactor materials, and Th-optimized 1000 Mwe HWOCR design. Work in the AEC/AECL program is reported on fluid dynamics and heat transfer, materials technology, fuel development, and irradiation programs. Operation of the Carolinas Virginia Tube Reactor is summarized. (J.R.D.)

24090 (SWRI-1228-56) EVALUATION OF THE SERVICEABILITY OF THE ELK RIVER REACTOR PRESSURE VESSEL. Progress Report No. 10, December 1, 1964–February 28, 1965. C. E. Lautzenheiser, José McDonald, Jr., Allen R. Whiting, and Paul D. Watson (Southwest Research Inst., San Antonio, Tex.). Mar. 15, 1965. Contract AT(11-1)-1228. 22p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Activities in a program to evaluate the effects of fabrication on low-cycle fatigue properties of pressure vessel steels are summarized. The fatigue properties of dissimilar welds simulating those found in the Elk River Reactor (ERR) pressure vessel nozzle are also being investigated. Fatigue curves for 8-, 10-, and 16-in.-nozzle dissimilar welds are included. Progress toward development of equipment and procedures for remote nondestructive monitoring and testing of ERR pressure vessel defects is reported. The feasibility of pulse-echo shear wave ultrasonic techniques for pressure vessel and closure head inspection was established. (J.R.D.)

24091 (TID-21500) ARDENNES NUCLEAR POWER PLANT. Quarterly Report No. 9, July 1–September 30, 1964. (Société d'Energie Nucléaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). Oct. 22, 1964. Work Performed under United States–Euratom Joint Research and Development Program. 54p. Dep.(mn); $3.00(cy), 1(mn) CFSTI.

Progress in plant design studies is summarized. Testing of prefabricated reactor components is reported and the status of on-site construction work is described. (J.R.D.)

24092 (TID-21501) 237-MW KRB NUCLEAR POWER PLANT. Quarterly Report No. 6, July 1–September 30, 1964. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). Work Performed under United States–Euratom Joint Research and Development Program. 124p. (Includes original). Dep.(mn); $4.00 (cy), 2(mn) CFSTI.

Repair and test work on the reactor containment shell in preparation for the pressure tests is reported. A pressure of 4.75 atm(g) was reached without any damage to the containment shell, and leakage tests were successfully carried

out at 3.8 and 0.5 atm(g). An examination of the shell revealed no cracks, and upon successful completion of the pressure test, work was started on the reactor building. The containment shell was corrosion-proofed inside and out, and by the end of the report period about half of the lower concrete had been laid. The turbine base-plate was laid, and finishing work was completed on the interior of the the turbine house. Construction of the coolant pump house including the workshop and storage building proceeded on schedule, and work on the coolant water outlet channel progressed faster than anticipated. About 100 m of the reinforced concrete canal can be concreted weekly, with the aid of prefabricated sliding shuttering. The finishing work on the administration block was completed, and it can now be occupied. The garage block was also completed, and finishing work on the other buildings progressed on schedule. The hot-well on the turbine house was welded together and mounted on its foundation, the coolant feed and discharge lines were laid, and the preheater crane was installed. The ventilation system for the reprocessing and reactor buildings was installed. Fabrication and delivery of the reactor pressure vessel and circulation pumps were delayed a few weeks beyond the date given in the schedule. (auth)

24093 (WAPD-MRP-111) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, October 24, 1964–January 23, 1965. Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT(11-1)-Gen-14. 97p. Dep.; $2.50(cy), 2(mn) CFSTI.

Core protection studies for Xe conditions other than full power equilibrium were completed. Cold plant mechanism, rod control, and nuclear instrumentation tests at Shippingport were completed successfully. A brazing method for the PWR pressure transmitted replacement program was successfully developed. Design of an additional engineered safeguard for PWR-2 was completed. The core power capability for concentrations of Xe intermediate between Xe-free and equilibrium-Xe, and between equilibrium-Xe and maximum-Xe, was examined, and operating limits were established for all Xe concentrations. The effect of hydraulically induced lateral vibrations on core power caused by reactivity variations was determined to be negligible. The flow stability limits of the core were established to serve as a basis for future design investigations. Examination of two irradiated model B-10 austenitic stainless steel poison plate elements irradiated 20% over anticipated irradiation levels of PWR-2 Seed 2 conditions showed that the proposed element design was satisfactory. A unique particle of segregated metallic fission products identified as consisting of Ru, Mo, and Rh was observed in an overheated (failed) fuel compartment of a PWR-2 Seed 2 plate element. The four samples required for the VH3-60 test were fabricated, evaluated, certified, and shipped on schedule for December insertion. Additional results were obtained from the spent component examination program, all of which confirm predictions as to component service capability. Calculations were made to determine the decay heat generation for each specific shipment of spent fuel. Preparations for hydrostatic testing were discontinued when a structural failure was observed in an upper structural support of one B & W steam generator. Temporary supports were constructed and remedial work initiated. (auth)

24094 (WCAP-3385-2) SAXTON PLUTONIUM PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING DECEMBER 31, 1964. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan. 1965. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3385. 93p. (EURAEC-1304). Dep.(mn); $3.00 (cy), 2(mn) CFSTI.

Progress is reported in the calculation and formulation of specifications for the nuclear fuel design; the mechanical, thermal, hydraulic, and materials aspects of fuel design; the performance of critical experiments; fuel fabrication, inspection, assembly, and shipping; alpha protection; and safeguards analysis for the Saxton Reactor. The purpose of the Saxton Plutonium Project is to develop information concerning the utilization of plutonium-enriched fuel in pressurized water reactor systems. (W.L.G.)

24095 (YAEC-124) YAEC DEVELOPMENT PROGRAM FOR THE PERIOD JULY 1 TO DECEMBER 31, 1959. H. E. Walchli (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Dept.). July 1959. For Yankee Atomic Electric Co., Boston, Mass. Contract AT(30-3)-222. 54p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Plans for research and development are summarized for programs on fuel elements, nuclear design, reactor physics, chemistry, mechanical design, thermal and hydraulic design, control rods, plant safety, criticality, and radiation damage. Budgetary information for the period is included along with a bibliography of topical reports issued. It is noted that progress in the program to July 1959, includes reactor design, development of fuel preparation methods, development of core fabrication methods, calculation of Yankee core temperatures and nuclear characteristics, completion of coolant flow experiments, analysis of core and control system performance, completion of critical experiments using Yankee fuel rods, fabrication of an in-pile loop for radiation testing, fuel element irradiation testing, development of control rod drive mechanism, and development of a universal handling tool. (J.R.D.)

24096 (YAEC-143) YAEC DEVELOPMENT PROGRAM FOR THE PERIOD JANUARY 1 TO JUNE 30, 1960. H. E. Walchli (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Dept.). Nov. 1959. For Yankee Atomic Electric Co., Boston, Mass. Contract AT(30-3)-222, Subcontract No. 1. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Plans for research and development to be performed during the first six months of calendar 1960 are summarized. A budget summary for the period is included. The basic objectives of the research program are listed along with accomplishments up to November 1959. (J.R.D.)

24097 (ORNL-tr-537) KARLSRUHE FAST BREEDER PROJECT. Annual Report, 1963. W. Schikarski, comp. Translation of "Projekt Schneller Bruter Karlsruhe, Jahresbericht 1963." May 1964. 85p. Dep.(mn); $8.10(fs), $2.75(mf) JCL.

The status of work in individual research and development programs is summarized, and past developments in the project are reviewed. Past efforts resulted in the design of a He-cooled power reactor, design and development of zero-power reactor facilities, and design of a subcritical assembly facility for pulsed-neutron investigations of fast reactors. During the report period, efforts were directed toward fuel cycle and fuel element development. (J.R.D.)

24098 (ORNL-tr-538) KARLSRUHE FAST BREEDER PROJECT. Third Quarterly Report, 1964. Translated for Oak Ridge National Lab., Tenn. from "Projekt Schneller Bruter Karlsruhe. 3. Vierteljahresbericht 1964." Sept. 1964. 34p. Dep.(mn); $3.60(fs), $1.22(mf) JCL.

Research and development are reported on SNEAK, STARK, SUAK, and SEFOR. Progress is reported on fuel element and fuel cycle development, and on the development of reactor component test equipment. Research is also reported on reactor instrumentation and reactor physics. Design work is reported on fast breeder reactors using sodium, steam, and helium as coolant. (J.R.D.)

24099 POWER REACTOR FUEL MANAGEMENT OPTIMIZATION. M. P. Lownfeld and E. D. Kendrick (Allis-Chalmers Mfg. Co., Bethesda, Md.). Atomics, [18]: 8(Mar.-Apr. 1965).

Results of a fuel management optimization taking into account the various fuel loading patterns for multizoned cores are presented. Several fuel management programs were analyzed for a slightly enriched UO_2 fueled, water moderated reactor having fuel elements made up of square arrays of fuel rods. (C.E.S.)

24100 THE VENTILATION OF POWER REACTOR OPERATING ROOMS AFTER SHUT DOWN. E. Sauter (Siemens-Schuckertwerke AG, Erlangen, Ger.). Atomkernenergie, 10: 63-7(Jan.-Feb. 1965). (In German)

The ventilation rate of the room and the rate of air dilution by addition of secondary air are calculated in

such a way that the sum of the concentrations relative to the MPC-values of the various isotopes and the output of the chimney are kept at constant values. The calculation takes into account the decay of radioactive isotopes and the efficiency of the filters provided in the air circulating system and in the channel to the chimney. This makes it possible to calculate the reduction of air activity in the room and the ventilation time necessary to reduce the air activity (relative to MPC-values) to a given value. (auth)

24101 GENERALITIES CONCERNING THE GAS-HEAVY WATER REACTOR SYSTEM. Bernard Bailly du Bois and Roger Naudet. Bull. Inform. Sci. Tech. (Paris), No. 87, 5-9(Oct. 1964). (In French)

The combination of heavy-water moderator and carbon-dioxide coolant at high pressure provides a favorable neutron economy, enabling natural uranium oxide with high specific power and burn-up and good steam characteristics to be used. The main advantages and particular technological problems of this reactor system are reviewed; various solutions are described. A survey of present research is given. The construction of the first large-scale power station of this type, the EL 4, is mentioned. Current reactor-system studies are more concerned with simplifications and savings which can be introduced into future power stations than with present, already very satisfactory, performances; long-term research offers interesting possibilities for other solutions. (auth)

24102 IRRADIATION OF FUELS FOR THE HEAVY-WATER SYSTEM IN THE PILE "PEGASE." J. P. de Sarrau. Bull. Inform. Sci. Tech. (Paris), No. 87, 39-44(Oct. 1964). (In French)

The program for irradiation testing of whole fuel elements (clusters) for the heavy-water reactor system is reviewed. Power, aerothermal, and mechanical conditions under which irradiation is carried out are described, and difficulties encountered in the measurement of instantaneous flux, integral flux, CO_2 temperature, cladding temperature, coolant inventory, and fuel losses are considered. Conclusions from the tests and future objectives are outlined. (M.J.T.)

24103 STUDY OF NEW MECHANICAL STRUCTURE IN THE HEAVY WATER–GAS DEVELOPMENT LINE. Roland Roche. Bull. Inform. Sci. Tech. (Paris), No. 87, 45-9(Oct. 1964). (In French)

Problems arising from the two possible evolutions of the mechanical structures used in the development of the heavy water–gas reactors are briefly outlined. One possible tendency is toward a type of reactor close to EL 4, but incorporating improvements such as proportionally fewer channels, pipes allowing faster assembly, and more compact systems. The other tendency is toward reactors similar to those of the graphite–gas type and possessing their main features: verticality, prestressed concrete shielding, and integration. (auth)

24104 AEROTHERMAL STUDIES FOR REACTORS OF THE EL4 TYPE. Paul Gelin. Bull. Inform. Sci. Tech. (Paris), No. 87, 51-4(Oct. 1964). (In French)

The studies were centered on the specific problems arising from bunched fuel elements, and more particularly the pressure drops due to assembling parts and the temperature variations around the bunch elements. It was thus possible to determine satisfactorily the sheath hot points, the rod distortions, and the distortion stability conditions. In addition a general study on corrugations was undertaken to improve heat exchange. (auth)

24105 SOME PROBLEMS AND SAFETY TESTS RELATING TO GAS–HEAVY WATER REACTORS. A. Meunier. Bull. Inform. Sci. Tech. (Paris), No. 87, 69-78(Oct. 1964). (In French)

Main safety problems involved in a pressure-tube power reactor moderated by heavy water and cooled by CO_2 under pressure are briefly summarized. Special tests carried out on consequences of rupture of the primary circuit, rupture of a pressure tube, and rupture of a gas collector are described. (auth)

24106 EXPECTED PERFORMANCE OF AN EL 500. Roger Naudet. Bull. Inform. Sci. Tech. (Paris), No. 87, 79-81(Oct. 1964). (In French)

Principal characteristics of a hypothetical 500-Mwe power station, based on an extrapolation of EL 4, are given, including parameters of core geometry, power cycle, temperature, and neutron economy. Some economic considerations are also presented, resulting from an analysis of present data on construction costs. (auth)

24107 FUEL CYCLES IN GAS-COOLED HEAVY WATER REACTORS. Roger Naudet. Bull. Inform. Sci. Tech. (Paris), No. 87, 83-90(Oct. 1964). (In French)

General comments on the fuel cycle in a heavy-water gas-cooled reactor are made. Neutron balance and fuel and cladding cost estimates in a hypothetical reactor of this type are worked out; these estimates are used to compare the economics of fuel cycles using different types of canning material—Be, Zr–Cu alloy, Fe–Al alloys, and stainless steel. The use of natural vs very slightly enriched U is discussed. (M.J.T.)

24108 HIGH TEMPERATURE GAS-COOLED REACTOR DEVELOPMENT. Elec. Export Rev., 4: 13(Jan.-Mar. 1965).

Recent developments indicate that the capital cost of a commercial nuclear power station with high temperature gas-cooled reactors (HTGR) rated at over 500 Mw each may be below £ 50/kw with total generating costs of the order of 0.35d/kwh. With a gas outlet temperature suitable for modern steam turbine cycle an HTGR would be operating well below its maximum limitation so that it may be possible to include a closed-cycle MHD topper in the overall generating system. Experimental fuel has been run at 1400°C, and at 1900°C for a short time. Further experiments are to be carried out at 2000°C. The high thermal power density in the core of an HTGR (14 Mw/m^3 in the Dragon project, 5-10 Mw/m^3 in a commercial HTGR) leads to a reduction in the size of the pressure vessel and shield compared with previous gas-cooled reactor designs (1.78 Mw/m^3 for the advanced gas-cooled reactor and 0.7 Mw/m^3 for magnox reactors). This reduction in size enables higher pressures to be used, which reduces the pumping power required to circulate the coolant. The HTGR offers the possibility of near-breeding with a ceramic fuel in which the fertile and fissile material and the moderator are mixed together. Ceramic fuel can withstand high burn-ups and it is expected that 150,000 Mw-days/ton may be achieved. On the basis of these advantages, work was initiated at Harwell to study the HTGR concept despite formidable problems of fission product removal, graphite corrosion and carbon deposition, activity in the coolant circuit, and leak tightness. In 1959 an agreement was made for research and design and construction of an HTGR experiment (the Dragon project) at a cost of 13.6 million over five yr. In 1962 this agreement was extended for a further three yr with the additional aim of providing information leading to the design of a commercial reactor and the budget was increased to 25 million. The 20 Mw (heat) experimental reactor, which has been built at the UKAEA's Winfrith establishment, went critical in August 1964. The earliest date for the commissioning of a commercial prototype will be in the early 1970's. The primary coolant of the Dragon reactor experiment is He and the maximum gas outlet temperature is 750°C at a pressure of 294 psi. Coated particle fuels were developed and experimental work has shown that these compacts have good fission product retention properties. (BBB)

24109 NUCLEAR-POWERED ELECTRODIALYSIS FOR DESALINATION. A. Hitchcock (Atomic Energy Establishment, Winfrith, Eng.), A. A. L. Minken, and J. W. Minken. Euro Nucl., 2: 79-84(Feb. 1965).

The extent to which electrodialysis can be an economic means of obtaining fresh water from salt water, when nuclear reactors are used as energy sources, is examined. Comparisons between electrodialysis and flash distillation as a means of obtaining large volumes of fresh water are presented. The two processes are shown schematically, and comments are made of the differences in plant behavior and product. (L.B.S.)

24110 OBRIGHEIM NUCLEAR POWER STATION. Euro Nucl., 2: 145-6(Mar. 1965).

A nuclear power station at Obrigheim was designed. It has a light, pressurized-water reactor. It is expected that the plant will generate electricity at a lower unit cost than a modern conventional station in the same area. The output is expected to be 283 Mw(e) and 907.5 Mw(t). (M.C.G.)

24111 CIRCUITS FOR THE DETECTION AND LOCALIZATION OF BURST FUEL ELEMENTS IN A NUCLEAR REACTOR COOLED WITH ORGANIC FLUIDS. PART I. F. Cesari (CNEN, Rome). Ing. Nucl., 5: 3-13(Nov.-Dec. 1964). (In Italian)

The function of the system and the principles on which it operates are presented. The various components of the circuit that are necessary for its functioning and their insertion within the container of the PRO plant are illustrated. A discussion on the charge loss and the associations that can cause it is presented. (tr-auth)

24112 THE THERMAL DIFFUSION COLUMN OF THE 'DRAGON' REACTOR. H. W. Grotendorst, D. Heymann, J. Kistemaker, J. Los, C. A. Velds, and A. E. de Vries (FOM, Amsterdam, Netherlands). J. Nucl. Energy, Pt. A & B, 19: 235-45(Apr. 1965).

Experiments are described which prove that the thermal diffusion column is a very reliable instrument to enrich extremely small amounts of impurities in a gas to a level where they may be analyzed by ordinary means. The method is particularly useful when a continuous check is needed. Enrichments of a factor of 100 are reached in 5-10 hr, while much larger enrichments may easily be obtained by increasing the length of the column. The method can be used in all cases where the gases are stable over a range of a few hundred degrees. A great difference in mass is favorable. Smaller mass differences would increase the time needed for a given enrichment. (auth)

24113 REACTOR CONTROL AT THE HINKLEY POINT NUCLEAR STATION. R. B. Quarmby and H. Law. Kerntechnik, 7: 124-5(Mar. 1965).

The two reactors at the Hinkley Point Nuclear Station, each with a thermal power of 980 Mw, are built with more than the critical amount of fuel, and neutron absorbing rods are provided to control the excess reactivity, which amounts to about 5%. Disposition of control rods in the reactor area is shown and the functions of the different kinds discussed. Motors for driving the rods are described. External controls and closed-loop control are also discussed. (M.C.G.)

24114 PROJECT DESCRIPTION (STATEMENT OF SPECIFICATIONS, OBTAINING OF BIDS, EXAMINATION OF BIDS INCLUDING CONSIDERATIONS RELATIVE TO FUEL CYCLES) [FOR OBRIGHEIM NUCLEAR POWER PLANT]. R. Kallenbach (Geschaftsfuhrer der Kernkraftwerk-Baden-Wurttemberg-Planungsgesellschaft mbH, Stuttgart). Neue Tech., 7: 8-19(Feb. 1965). (In German).

Experiences acquired when planning the Obrigheim nuclear power plant are described. On the basis of these experiences a guide is laid down for the drawing up of plans for nuclear power plants. (auth)

24115 ECONOMIC INTEGRATION OF NUCLEAR POWERPLANTS INTO THE EXISTING ELECTRICAL PRODUCTION NETWORKS. R. Janin (Electricite de France, Paris). Neue Tech., 7: 20-6(Feb. 1965). (In French).

The integration of nuclear plants into an existing production complex is discussed. In particular, the characteristic dimensions, which define a network's possibilities, change their definition with the increase in the proportion of atomic energy. It is shown that the development of nuclear power in a network that already contains hydraulic and thermal plants does not lead to the same problems as the integration of nuclear plants in an entirely hydraulic network. By means of a diagram it is possible to show the particular developments in the Swiss and French grids. Large units are favorable to the economy of the nuclear power. It is also considered advisable to weigh the uncertainties within the framework of the network concerned. It appears that equipment must be adapted to the progressive development of nuclear production, which will lead to a structural evolution appropriate to each country. (auth)

24116 THE CHARGE/DISCHARGE MACHINE FOR THE DRAGON REACTOR. P. A. Ribaux (B. P. Secheron, Geneva). Neue Tech., 7: 36-46(Feb. 1965).

The charge/discharge machine for the DRAGON reactor located in Winfrith, England, is described. Some of the special problems encountered, such as friction in helium and leak tightness, are dealt with. After extensive tests in the works, the machine was erected on site where it was again submitted to thorough tests, first in air and later in hot helium. (auth)

24117 THE ORGEL PROJECT. J. C. Leny (Euratom, Ispra, Italy) and S. Orlowski. Nucl. Eng., 10: 96-100 (Mar. 1965).

The present status of the research program associated with ORGEL, a heavy water moderated, organic cooled reactor system, is summarized. Descriptions and photographs are given of the organic loop for full-scale testing, facility to study the burst of pressure tubes and the related safety problems, critical and exponential facilities (ECO and EXPO), hot laboratory for irradiated pressure tubes (ESSOR), and the ESSOR complex. Characteristics of the power reactor, and of an ORGEL industrial steam and electricity power plant are tabulated. The expected energy costs for ORGEL plants of different sizes when the industrial stage is reached are given. (L.B.S.)

24118 A PERSPECTIVE ON STARTUP EXPERIENCE. Nucleonics, 23: No. 3, 46-7(Mar. 1965).

The procedures preceding startup are briefly discussed with consideration of factors that may delay startup and with reference to specific reactors. The personnel requirements for startup are briefly considered. (D.C.W.)

24119 TESTING NONNUCLEAR COMPONENTS AND SYSTEMS. S. D. MacKay (Allis Chalmers, Bethesda, Md.). Nucleonics, 23: No. 3, 48-51(Mar. 1965).

The preoperational testing of reactor buildings, process systems, mechanical systems, and instrumentation prior to fuel loading is outlined, together with the checks made on equipment and systems that can affect reactivity during loading and zero-power testing. The tests that are performed during power escalation are also considered. (D.C.W.)

24120 REACTOR LOADING AND PHYSICS TESTS. Joseph A. Thie. Nucleonics, 23: No. 3, 52-5; 60(Mar. 1965).

The tests performed on power reactors at zero power, low power, and during power escalation are outlined. The tests performed at some currently operating power plants are indicated, together with some testing difficulties. (D.C.W.)

24121 PREDICTING CRITICALITY AND NUCLEAR CHARACTERISTICS. Thomas R. Robbins, Sol Sandhaus, and Warren F. Witzig (Nuclear Utility Services, Inc., Washington, D. C.). Nucleonics, 23: No. 3, 56-60(Mar. 1965).

The reasons for the uncertainties in present calculations of reactor characteristics are briefly discussed, together with their consequences and the methods used to accommodate t'iem. The measured and predicted characteristics of some operating power reactors are listed as examples. (D.C.W.)

24122 PERSPECTIVE ON STEAM CYCLES FOR NUCLEAR POWER PLANTS. J. A. Signorelli (Nuclear Utility Services, Inc., Washington, D. C.). Nucleonics, 23: No. 4, 45-9; 61(Apr. 1965).

The economic balance between capital costs and low fuel costs for a nuclear plant is discussed in light of the increasing nuclear plant costs for higher thermal efficiencies. The trend to increased plant efficiencies, resulting from improved steam conditions and larger plant size, is shown. Factors relating to the optimization of power plant designs are discussed. Steam-cycle parameters for nuclear power plants are tabulated. (L.B.S.)

24123 ADVANCES IN HIGH-POWER-DENSITY BWR'S. PART I. TOWARD LOW-COST HIGH-PERFORMANCE BWR FUEL. R. N. Duncan, W. H. Arlt, and J. S. Atkinson (General Electric Co., San Jose, Calif.). Nucleonics, 23: No. 4, 50-4(Apr. 1965).

A total of 36 stainless-steel-clad high-power-density UO_2 fuel assemblies designed for a lifetime of 10,000 Mwd/ton U were irradiated in the VBWR, and were examined for fuel cladding failures. The assemblies were operated at power densities >100 kw/l average and at heat fluxes 480,000 Btu/hr/ft^2. The fuels, fabricated by processes that offer greatest potential for cost reduction and improved performance, began to show failures in the stainless-steel cladding the range of 5,000 to 9,000 Mwd/ton U. The failures led to the use of alternate cladding materials in addition to 304 stainless steel in the fabrication of developmental fuel assemblies in the core at Big Rock Point, including Incoloy-800, Inconel-600, and Zircaloy-2. (L.B.S.)

24124 PILE SIMULATORS. M. Chaigne (CEN, Cadarache, France), R. Abdon, and J. Ladet. Onde Elec., No. 448-9(July-Aug. 1964). (In French). (EUR-2144.f)

After general considerations, the Rapsodie analog simulator is described, and, briefly, the land based prototype simulator. Finally, the results obtained for the digital simulation of Rapsodie are mentioned. The latter type of simulation is considered to be the better solution for the future. (auth)

24125 NUCLEAR POWER REACTORS. R. K. Evans. Power, 109: No. 3, S1-24(Mar. 1965).

A brief survey on power reactor designs is presented with consideration of neutron physics, fuel-element design, control, superheating, coolant-fuel-moderator combinations, and safety. The notable features and merits of each design are summarized. The future of nuclear power is briefly discussed, including the use of breeder reactors. (D.C.W.)

24126 ELECTRICAL FEATURES OF AN ATOMIC GIANT. Floyd D. Robbins. Trend Eng. Univ. Wash., 17: No. 1, 5-13; 27(Jan. 1965).

Safety requirements for a nuclear reactor are rigorous and uncompromising. Strict reactor criteria can be satisfied only if the electrical power supply and control system meet a similar set of criteria. The unusual problems arising in the electrical network when these criteria are applied to a dual-purpose reactor supplying steam to a large station generating electric power. The Hanford power-generation project, which is served from the N-Reactor, is discussed in the light of operational tests to be performed prior to incorporation of the project into the complex Northwest power network. The impact of such tests on the Hanford reactor system, the N-Reactor, and the power pool are related. A brief description is given of the thermal and electrical elements of the project as planned, with reference to the present status of construction. This will be the largest nuclear-electric generating station in the world and the first major 500-kv installation in the United States; thus it is a pioneer research center that will help determine the progress of nuclear-electric power. (auth)

24127 POSSIBILITIES FOR THE USE OF NUCLEAR POWER IN LATIN AMERICA. Washington, D. C., Pan American Union, 1964. 54p.

The status of nuclear power generation is reviewed with consideration of the economic and technical aspects, reactor evaluation and selection criteria, and procedures in nuclear plant installation. The power costs, demands, and reserves in areas and countries of Latin America are then summarized, together with the desirability of nuclear power for these regions. (D.C.W.)

24128 NUCLEAR REACTORS. PRESENT STATE OF A TECHNIQUE DEVELOPED BY PHYSICISTS. W. Finkelnburg. p.55-70 of "Physikertagung Hamburg." Mosbach/Baden, Ger., Physik Verlag, 1964. (In German)

The discussion of the present state of nuclear reactors is limited to a consideration of power plant reactors producing a usable power. The various reactor types studied as power producers and their advantages and disadvantages are described. (J.S.R.)

24129 PREDICTION OF MIDLIFE POWER DISTRIBUTION IN THE INDIAN POINT REACTOR. David R. Hostetler (Babcock and Wilcox Co., Lynchburg, Va.). 18p. (CONF-654-43)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Axial and radial power distributions in the Indian Point Reactor just before the midlife shutdown for removal of the fixed shims were measured and also calculated using depletion and smeared-poison simulation techniques. The distribution of Ba–La fission products in the core was determined from the power distributions. ^{140}Ba and ^{140}La activities along selected fuel elements were scanned. The measured and calculated Ba–La activities are compared and used for a check on the accuracy of the power-distribution calculations and measurements. (M.J.T.)

24130 PROGRAM FOR THE PREVENTION OF CARBURIZATION OF STEEL CORE COMPONENTS AT THE HNPF. A. I. Hansen, H. J. Rubinstein, and E. N. Pearson. 17p. (CONF-654-64)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The hot-trapping program used to control the carbon content of the sodium coolant of the Hallam power reactor is discussed. The hot-trapping system and the analyses made on cladding samples and coolant after removal from the system are described, and the results of analyses are presented. No evidence of carburization has been observed. The calculations by which the frequency of hot trapping was established are outlined. (D.C.W.)

24131 MEASURED AND CALCULATED FISSION DISTRIBUTIONS IN THE ENRICO FERMI FAST BREEDER REACTOR. R. E. Horne and E. M. Page (Atomic Power Development Associates, Inc., Detroit). 27p. (CONF-654-57)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Measurements and multigroup diffusion theory calculations of the ^{239}Pu, ^{234}U, ^{235}U, and ^{236}U fission distributions in and around the core of the Fermi Fast Breeder Reactor are summarized; the results are presented and compared. The results show that accurate predictions of the fission distribution can be obtained using two-dimensional multigroup diffusion theory with sufficient groups to portray spectrum changes and with due consideration of the geometry. (D.C.W.)

24132 PNPF PROGRESS REPORT FROM CRITICALITY TO FIRST SCHEDULED SHUTDOWN (JUNE 1963-MAY 1964). C. A. Trilling, H. J. Rubinstein, J. Jacobson, O. Teszler, and R. R. Stiens. 31p. (CONF-654-65)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The operation and performance of the Piqua Nuclear Power Facility from critical and power testing to the first scheduled shutdown on May 21, 1964, are reviewed. The only difficulty encountered was associated with the control rod drive and position indicating circuitry. The reactor demonstrated excellent load-following characteristics, and the performance of the heat-transfer and coolant-purification systems was very good. The absence of fouling indicated by the operating temperatures of the fuel elements was confirmed by hot-cell examination of the first fuel element removed from the reactor after irradiation to about 33% of burnup. Fuel swelling was found to be less than expected, and radiation levels were low enough to allow complete access to the containment shell and contact maintenance of the primary coolant system during operation. Initial operating experience indicates that the plant could operate well above the design value of 45.5 Mwt. (D.C.W.)

24133 MODERATED INTERMEDIATE-SIZED FAST OXIDE CORES. J. B. Nims, A. E. Klickman, E. M. Page,

and C. S. Yeh (Atomic Power Development Associates, Inc., Detroit). 8p. (CONF-654-79)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The effects of mixing BeO with the PuO_2-UO_2 fuel of a 600-l sodium-cooled reactor were investigated for both normal cores and collapsed (melted) cores. The total energy release during the excursion and the available work were calculated. The variation of the Doppler coefficient with BeO content and the effect of the variation in the Doppler coefficient were studied. The results show that the energy release and damage capability in core collapse can be improved significantly by moderating the neutron spectrum without excessively affecting other characteristics. (D.C.W.)

24134 FLOATING NUCLEAR POWER PLANT. Henry Gitterman. 4p. (CONF-640810-5)

From Conference on Nuclear Marine Propulsion, Blacksburg, Va.

Factors in the analysis, design, and evaluation of a floating nuclear power plant (barge- or ship-mounted reactor) are outlined. (D.C.W.)

24135 MID-LIFE POWER DISTRIBUTION IN THE INDIAN POINT REACTOR. M. L. Batch, R. M. Ball, R. H. Lewis, and R. H. Freyberg, Jr. (Babcock and Wilcox Co., Lynchburg, Va.). 12p. (CONF-654-62)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

The detector system used in measurement of the fission produce distribution in fuel elements from the Indian Point Reactor is described, and the data reduction techniques are outlined. The measurements were made to determine the power distribution in the core and to establish the degree of power symmetry throughout the core. (D.C.W.)

24136 AN EXPERIMENTAL INVESTIGATION INTO THE THRESHOLD OF DEPARTURE FROM NUCLEATE BOILING (DNB) IN A D_2O-MODERATED REACTOR. J. A. Norberg and R. L. Johnson. 10p. (CONF-654-58)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

A series of tests on the Spert II reactor facility is described in which the threshold power level for the departure from nucleate boiling was experimentally determined. The effect of the reactor power history on the threshold was studied using various reactivity perturbations. At the system conditions considered, the threshold was found to be 100 to 105 Mev, and gross differences in power history had no detectable effect on the threshold. The experimental observations were compared with theoretical predictions. (D.C.W.)

24137 DEVELOPMENT OF A PRODUCTION LINE TECHNIQUE FOR ULTRASONIC TESTING OF CORE ELEMENTS FOR ENRICO FERMI NUCLEAR REACTOR. A. R. Mylenek (Detroit Edison Co.). 33p. (CONF-778-5)

From Metals/Materials Congress, Philadelphia, Oct. 1964.

Specifications were established for the fuel elements by sensitive and dependable ultrasonic through-transmission testing techniques. Internal defects $\frac{1}{64}$ inch (0.015 inch), non-bonds between the uranium and zirconium clad, clad surface defects, and accurate measurement of the cladding thickness, at any point, 0.003 inch minimum, 0.007 inch maximum and an average thickness through any section of 0.0045 inch minimum, 0.0055 inch maximum, were the results of the excellent feeder and collimation design. A slide presentation and description of the design of the collimator and the actual operation are given. Also a slide presentation is given of the various defects, clad measurements, instrument data and destructive test data which were correlated to establish acceptable standards. (auth)

24138 CONTAINMENT VESSEL CABLE PENETRATION AND TERMINATION DEVELOPMENT FOR THE INDIAN POINT NUCLEAR POWER PLANT. W. C. Dumper and J. G. Noest (Consolidated Edison Co. of New York, Inc., New York). New York, Institute of Electrical and Electronics Engineers, 1964, Preprint Paper No. 31 CP 65-155, 12p, $1.00. (CONF-650105-4)

From Institute of Electrical and Electronic Engineers, Winter Power Meeting, New York.

The integrity of any nuclear containment vessel is highly dependent upon the method of sealing the electric cables which penetrate the vessel. Three types of electric cable penetration seals are employed at the Indian Point Nuclear Power Plant of the Consolidated Edison Company of New York, Inc. Large power cables utilize factory constructed, 3-phase solder-sealed pothead assemblies. Multiconductor control cables are spliced at the containment wall and filled with an epoxy sealing compound. Coaxial cable penetrations utilize factory assembled units incorporating soldered ceramic connectors. In addition, all cables located within and penetrating the containment vessel are of special construction highly resistant to axial gas flow and are provided with termination seals at the equipment. (auth)

24139 NUCLEAR POWER AND NIAGARA MOHAWK. J. Norton Ewart (Niagara Mohawk Power Corp., Buffalo). New York, Inst. of Electrical and Electronic Engineers, 1964, Preprint Paper CP 65-212, 29p, $1.00. (CONF-650106-2)

From Institute of Electrical and Electronic Engineers, Winter Power Meeting, New York.

The suitability of the Niagara Mohawk System for large-scale thermal and nuclear plants is discussed. Economical and technical considerations for constructing a nuclear power plant for the proposed Nine Mile Point site are discussed. A summary is presented of the pertinent design features and operations of the Nine Mile Point nuclear station, along with accompanying diagrams. (L.B.S.)

24140 ANALYTICAL STUDY OF POWER MATCHING IN THERMIONIC REACTOR CORES. P. R. Hill and A. J. Gietzen (General Electric Co., Pleasanton, Calif.). 27p. (CONF-654-82)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

An analysis of the thermal power profiles and electrical performance of a 1-Mw(e) thermionic reactor is outlined, in which compensation for effects of non-uniform power distribution by fuel distribution was studied. The fission distributions corresponding to various fuel distributions were calculated, together with the electrical output and efficiency as functions of thermal power. It was concluded that the full potential of a thermionic reactor can not be achieved without flattening the fission distribution profile. (D.C.W.)

Process Heat Reactors

24141 MEASURING FUEL ROD CENTRE TEMPERATURES. G. Kjaerheim. Euro Nucl., 2: 72-7(Feb. 1965).

The central UO_2 fuel temperature was measured at HBWR on three instrumented fuel assemblies to investigate the real relation between central fuel temperature and specific power, using W/Re and W/W 26% Re thermocouples. The mechanical design of the thermocouples and the installation technique are described. The results were found to agree fairly well with calculated temperatures, within the range in which thermal conductivity data were available. The measurements indicate that central fuel temperatures are not likely to limit the specific powers of D_2O boiling channels. (L.B.S.)

24142 DESALINATION FOR THE FUTURE. Dieter Zibis. Euro Nucl., 2: 134-5(Mar. 1965).

Uses of nuclear reactors to produce heat for distillation of sea water are discussed. World water requirements are also considered. (M.C.G.)

Production Reactors

Refer also to abstract 22504.

24143 (HW-83899) EDDY CURRENT TESTING REPORT FOR N-REACTOR DUMP CONDENSERS. J. C.

Spanner, R. L. Brown, Jr., and R. W. Moss (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 2, 1964. Contract AT(45-1)-1350. 21p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The results of eddy current testing conducted on the N-Reactor dump condensers are summarized. The dump condensers, each containing 2547 tubes made of Cupronickel, are described. It was found that the most severe cases of band fret took place on the outside rows where they could be visually detected. The chemical and metallographic analysis are briefly outlined. (C.E.S.)

24144 AUTOMATIC SYSTEM MONITORS WATER QUALITY IN NEW ATOMIC PLANT. Walter D. Bainard (General Electric Co., Richland, Wash.) and Paul W. Gottschalk. Power, 108: No. 11, 74-7(Nov. 1964).

An automatic system is described, which continuously collects and analyzes samples from the water systems of the graphited-moderated, light-water-cooled New Production Reactor at Hanford. (D.C.W.)

Propulsion and Space

See also ENGINEERING — Space Propulsion.

24145 (AD-606336) THRUST OPTIMIZATION OF A NUCLEAR ROCKET OF VARIABLE SPECIFIC IMPULSE. H. R. Lawrence, C. J. Wang, and G. W. Anthony (Ramo-Wooldridge Corp., Los Angeles, Calif. Space Technology Labs.). May 29, 1958. 25p. $1.00(CFSTI).

A relation is derived between the specific impulse and the flow rate of a gas under reactor operating conditions, allowing molecular dissociation of the gas. Utilizing this relation, an optimum variable-thrust program to maximize velocity is obtained for a vertically ascending vehicle under the assumptions of constant gravity and zero aerodynamic drag. The advantage of this program is demonstrated by comparison with the usual constant thrust program. (auth)

24146 (NAA-SR-Memo-10704) STATIC STRUCTURAL TEST OF THE ALUMINUM–STEEL RADIATOR CONDENSER (R/C-10). W. P. Engle (Atomics International, Canoga Park, Calif.). Nov. 12, 1964. Contract AT(11-1)-Gen-8. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The R/C-10 structure was subjected to a two-phase static structural test. (a) Phase I: Aerodynamic pressure distribution in combination with 100 per cent limit loads. (b) Phase II: Aerodynamic temperature application in combination with end boost condition loads. The structural integrity of the aluminum-steel R/C concept was proven. Areas of design modifications, for future aluminum-steel radiator condensers, were disclosed by this test program. Recorded data have permitted analysis verification. (auth)

24147 (NAA-SR-Memo-10730) TANTALUM FOIL INSULATION FOR LIQUID METAL COMPONENTS OPERATING AT 1000-1400°F, IN VACUUM. J. R. Crosby (Atomics International, Canoga Park, Calif.). Dec. 1, 1964. Contract AT(11-1)-Gen-18. 11p. Dep.(mn); $1.00 (cy), 1(mn) CFSTI.

Liquid metal components for use on the SNAP 10A follow-on system, the Mercury Rankine Program, and the SNAP 8 system operate at temperatures up to 1300°F in vacuum. To prevent excessive heat losses, it is necessary to thermally insulate these components with materials which are compatible with overall system requirements. A foil insulation configuration which exceeds system requirements (ϵ = .05) was designed and tested. This configuration consists of two layers of dimpled tantalum foil which are wrapped around the liquid metal components. The dimples in each tantalum foil layer minimize thermal contact between 1) the component (e.g., stainless steel tubing) and the inner foil and 2) the inner and outer foil. For a component temperature of 1300°F, the effective emittance of this configuration was measured to be 0.04. (auth)

24148 (NASA-CR-210) THEORETICAL INVESTIGATION OF THE ABSORPTION AND SCATTERING CHARACTERISTICS OF SMALL PARTICLES. N. L. Krascella (United Aircraft Corp., East Hartford, Conn.). Apr. 1965. Contract NASw-847. 60p. $3.00(CFSTI).

A theoretical investigation was conducted to determine the absorption, scattering, and extinction characteristics of small solid spherical particles which might be employed as seeding agents to control radiant heat transfer in gaseous nuclear rocket engines. The calculations were made using the Mie theory to determine the effect of particle size, wavelength, and particle temperature on particle opacity in those regions of the ultraviolet, visible, and infrared spectra for which complex index of refraction information was available. The following materials were considered: aluminum, carbon, cobalt, iridium, molybdenum, niobium, palladium, platinum, rhenium, rhodium, silicon, tantalum, titanium, tungsten, and vanadium. (auth)

24149 (NASA-CR-212) THERMODYNAMIC PROPERTIES OF COOLANT FLUIDS AND PARTICLE SEEDS FOR GASEOUS NUCLEAR ROCKETS. R. Roback (United Aircraft Corp., East Hartford, Conn.). Apr. 1965. Contract NASw-847. 24p. $1.00(CFSTI).

Thermodynamic properties and equilibrium chemical composition were calculated for various materials which could serve as moderator coolants or as particle seeds designed to control radiant heat transfer in gaseous nuclear rocket engines. The materials considered as moderator coolants were hydrogen, methane, water, ammonia, deuterium, heavy water, and helium. Materials considered as possible particle seeds were several elemental species that have high boiling points, such as graphite, tungsten, and molybdenum, and the oxides, carbides, nitrides, and borides of titanium and zirconium. The results of the calculations indicate that the use of graphite as a seed material is impractical because graphite reacts readily with hydrogen, and, consequently, excessive quantities of graphite must be added to the hydrogen stream in order to maintain even very small concentrations of seed particles at high temperatures. Also, the data indicate that no significant increase in particle vaporization temperature would result from using oxides, carbides, nitrides, or borides of such high-melting-point metals as titanium and zirconium as seeds in place of the metals themselves. (auth)

24150 (USNRDL-TR-811) RADIONUCLIDE RELEASE FROM AERO-SPACE NUCLEAR REACTOR FUELS. II. PHASE ONE: PULSED NEUTRON IRRADIATION OF DRY FUEL. J. L. Mackin, L. W. Weisbecker, and P. E. Zigman (Naval Radiological Defense Lab., San Francisco, Calif.). Jan. 18, 1965. Contract AT(49-5)-2084. 39p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The radionuclide release from NERVA fuel irradiated under pulsed-neutron conditions was investigated through the irradiation of a series of capsules in the General Atomics TRIGA Advanced Prototype Facility. The irradiation conditions produced a thermal neutron flux of 1.48×10^{14} n/cm^2 and an average of 1.32×10^{13} fissions per gram ^{235}U per Mw-sec. Approximately 1% of the fission gases were released, resulting in an internal capsule pressure rise of less than 5 psi. A maximum bulk fuel temperature of about 1200°F, was reached. No fuel damage was detected. No radiological safety problems were encountered. (auth)

24151 CAN WE AFFORD TO WAIT FOR NUCLEAR ROCKETS? Howard R. Schmidt (Lockheed Missiles and Space Co., Palo Alto, Calif.). Astronaut. Aeronaut., 3: No. 3, 16-25(Mar. 1965).

The capability of nuclear stages to perform a spectrum of advanced missions, with significant performance advantages is shown. It is seen, for instance, how integration of nuclear third stages with Saturn V can extend its useful life to include manned Mars-landing missions at least through the 1980s and possibly through the 1990s. The economic implications of using nuclear stages in the space program in this way were covered in qualitative terms based on experienced judgments. (L.B.S.)

24152 SHIELDING OF A BOILING WATER SHIP REACTOR. H. G. Fendler, A. L. Sellen, and K. Werner (AEG/Kernenergieanlagen, Frankfurt am Main). Atomkernenergie, 10: 11-22(Jan.-Feb. 1965). (In German)

A nuclear-powered tanker is discussed in which the

reactor and turbine are to be operated with live steam. The shielding requirements for the reactor and turbine are considered, together with means for meeting such requirements. Some proposals regarding primary shielding are also covered. The three-group neutron calculations and ten-group gamma calculations performed for the shielding selected are summarized, together with the results. (D.C.W.)

24153 PROBLEMS OF NUCLEAR MARINE PROPULSION. D. Ulken (Gesellschaft fur Kernenergieverwertung in Schiffbau und Shiffahrt e.V., Geesthacht, Ger.). Atompraxis, No. 4, 9: 3-8(1964). (In German). (EUR-1872.d)

The principal problems in the construction of marine nuclear drives are described. The modification in the ship construction caused by the introduction of a reactor and the safety problems connected with reactor operation on board ship are considered. The principal projects now under study in Germany are summarized. (J.S.R.)

24154 NATIONAL PRESTIGE—OR ECONOMIC NECESSITY? PART II. John C. H. Roberts. Euro Nucl., 2: 88-92(Feb. 1965).

Considerations are given to the design, construction, and economics of a British nuclear-powered surface vessel. The advantages and disadvantages of building such a vessel are discussed. (L.B.S.)

24155 VIRGINIA POLYTECHNIC INSTITUTE SYMPOSIUM AUGUST 12, 1964. NUCLEAR PROPELLED SHIPS—POLICIES AND PLANS. E. M. MacCutcheon. 9p. (CONF-640810-4)

From Conference on Nuclear Marine Propulsion, Blacksburg, Va.

The difficulties faced by the merchant marine with respect to labor costs, foreign competition, and obsolescence are summarized; and the benefits of nuclear power in relation to these difficulties are outlined, together with development plans and policies for nuclear propulsion. (D.C.W.)

24156 NEUTRONIC COUPLING OF CLUSTERED NUCLEAR ENGINES. J. S. Woyski and R. W. Langley (Douglas Aircraft Co., Inc., Santa Monica, Calif.). 25p. (CONF-654-48)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Nuclear propulsion engines operating in a cluster arrangement are subject to an exchange of neutron radiation. A method of analysis suitable for parametric studies to determine the degree of neutronic coupling and how it affects engine performance and control stability is presented. Results are presented for several representative nuclear engine designs in various cluster arrangements. The calculated reactivity coupling, using the Albedo concept to represent the interchange of neutrons, is compared to experimental data for two KIWI B reactors. (auth)

24157 MISSIONS AND FLIGHT OPERATIONS FOR NUCLEAR ROCKETS. Herbert Radd (Lockheed Missiles and Space Co., Sunnyvale, Calif.). 31p. (CONF-799-16)

From 11th Annual Nuclear Science Symposium, Philadelphia, Oct. 1964.

A historical review of nuclear rocket missions and flight operations data as taken from ground tests and non-nuclear flight tests is given. Solid-core nuclear engines are considered for a wide range of orbital, lunar, and interplanetary applications. (R.E.U.)

24158 UNIMOD, THE UNIFIED MODULAR PLANT FOR NUCLEAR MARINE PROPULSION. P. C. Zmola (Combustion Engineering, Inc., Windsor, Conn.). 7p. (CONF-640810-6)

From Conference on Nuclear Marine Propulsion, Blacksburg, Va.

Some advantages resulting from reactor plant compaction, as in the case of UNIMOD, are described quantitatively. The UNIMOD plant, a compact, pressurized-water marine reactor, designed for factory preassembly into a limited number of modules for ease of installation is described. The inherent turbine-demand control aspects of the self-compensating reactor are described. (R.E.U.)

24159 THE UNITED NUCLEAR M1U PROTOTYPE FOR MARITIME NUCLEAR PROPULSION. James V. Haley (United Nuclear Corp., White Plains, N. Y.). 6p. (CONF-640810-8)

From Conference on Nuclear Marine Propulsion, Blacksburg, Va.

A proposed land-based prototype of a nuclear propulsion plant, designed for demonstration of ship-reactor technology and training of ship crews, is described. The integral design uses forced-circulation, pressurized water in the primary system. (D.C.W.)

Research and Test Reactors

Refer also to abstracts 21808, 22509, 22737, and 24064.

24160 (AERE-M-1535) A LIST OF MATERIALS WHICH MAY BE ACCEPTED FOR IRRADIATION IN BEPO BY THE SHIFT MANAGER, WITHOUT REFERENCE TO THE REACTOR MANAGER. J. K. Linacre (Atomic Energy Research Establishment, Harwell (England)). Feb. 1965. 33p. Dep.; $0.90(BIS), 4s. 6d. (HMSO).

In order to ease arrangements for the acceptance of irradiations in BEPO, lists are given of materials that have been irradiated in the past, and conditions under which the irradiations may safely be performed are specified. Irradiations on the list may then be accepted by the duty Shift Manager, from any responsible officer, without reference to the Reactor Manager. The list is subdivided under the headings: inorganic chemicals; metals and alloys; gases; aqueous solutions; and miscellaneous materials, such as minerals. (P.C.H.)

24161 (BLG-262) ESSAI DE MARCHE EN PUISSANCE DE LA CENTRALE NUCLEAIRE BR3 EN PRESENCE DE BORE DANS LE CIRCUIT PRIMAIRE. (Test of Increase in Power of the BR3 Nuclear Power Station with Boron in the Primary Circuit). M. Gueben, P. Stacquez, J.-P. Contzen, F. de Greef, and G. Beuken (Centre d'Étude de l'Énergie Nucleáire, Brussels (Belgium)). Mar. 1964. 33p. Dep.(mn).

A BR3 power production test with a boron concentration of 400 ppm was undertaken. Preliminary calculations concerning the dynamic behavior of the reactor—controlled by 400 ppm of boron—in case of load transients, and a study of the safe functioning of these reactors with boron (boric acid) present, showed that the test would be perfectly feasible. Also, the results obtained while working with a low boron concentration, allowed the orientation of the test towards a double objective. A continuous supervision of the primary water chemistry and radiochemistry, the core reactivity during normal operation, and also a systematic examination of the phenomena noted after removal of the poison, assured the perfect safety of this method of control from the threefold point of view of core reactivity, air and water radioactivity, and corrosion of the primary circuits. An experimental chemical control program permitted the compensation of various slow transients, including Xe poisoning when starting after a short or long stationary period, compensation of fuel burnup and Sm poisoning, and all operations during which the reactor has been controlled uninterruptedly for several days only by altering the concentration of the boron and without moving the control rods. (auth)

24162 (BNL-8986) MEASUREMENT AND CONTROL OF RADIATION-INDUCED GROWTH OF THE BROOKHAVEN GRAPHITE REACTOR. Robert M. Singer and Dudley Thompson (Brookhaven National Lab., Upton, N. Y.). [1967]. Contract AT-30-2-GEN-16. 7p. (CONF-650602-19). Dep.(mn); $1.00(cy), 1(mn) CFSTI.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

Frequent cycles of irradiation and annealing have proven an effective means for regulation and removal of neutron induced dimensional expansions of graphite. These techniques have considerably lengthened the operational lifetime of the Brookhaven Graphite Reactor. Measurements obtained on small graphite monitoring samples dispersed

throughout the reactor and relative changes in the 25 ft height of the moderator are reported. In some cases, 65% of all previous dimensional damage was removed by the frequent irradiation and annealing cycles. (P.C.H.)

24163 (CNLM-5977) CONTAINMENT VESSEL LEAK RATE CRITERIA FOR A PROPOSED CANEL NUCLEAR TEST FACILITY. E. V. Sandin (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Aircraft Nuclear Engine Lab.). Dec. 2, 1964. Contract AT(30-1)-2789. 20p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Results are presented of a re-evaluation of the maximum allowable leak rate criteria to be used in the Title I design of the proposed CANEL Nuclear Test Facility. The criteria is based on the AEC reactor licensee guide "Reactor Site Criteria" usually referred to as 10 CRF 100. The analytical method and assumptions used follow closely those used in previous CANEL hazards analyses. The basic assumptions are: 1) 100% of all fission products resulting from 10,000 hours operation of a 10 Mw reactor are available to leak out of the containment vessel, 2) pressure decay resulting from natural heat convection and conduction reduces the leak rate to an average value of $\frac{1}{3}$ of the maximum for the duration of the leak, 3) the leak persists for 72 hours at which time pressure reduction equipment is activated to stop the leak, 4) the atmospheric diffusion of the released material is adequately described by the Sutton equation as incorporated in the CANEL HADES codes using the meteorological parameters determined by the U. S. Weather Bureau for the CANEL site, 5) persons outside the low population zone are not subject to evacuation or decontamination and are exposed to radiation from fallout from the effluent stream for 70 years, 6) the low population zone outer boundary is at 2.25 miles from the NTF based on the nearest boundary of high population density of Middletown, the nearest population center, being at 3 miles from the NTF. The largest doses were found to be the bone, fallout and rainout doses. The controlling dose was taken to be the sum of the bone and fallout doses. The resulting maximum allowable leak rate is 0.05% of the contained volume per day. The allowable leak rate for the present exclusion distance, taken as 4000 feet from the NTF, is 0.65% per day, based on the doses from the first 2 hours of the release. Discussions of on site doses and dose rates, effects of less conservative assumptions on availability of fission products, relationship to the previous evaluation of allowable leak rate and plots of doses, dose rates and allowable leak rates are included. It is concluded that the maximum allowable leak rate criteria for use in Title I design should be 0.05% of the contained volume per day. (auth)

24164 (CONF-640607(Vol.I)(Paper A-4)) IN-CORE MEASUREMENTS IN DENMARK. K. Haack (Atomenergikommissionen, [Copenhagen], (Denmark)). 10p.

Fundamental measurements carried out in the Danish reactor DR-3 are described, along with the instruments used in these measurements. (T.F.H.)

24165 (CONF-640607(Vol.I)(Paper A-12)) STATUS OF IN-CORE INSTRUMENTATION DEVELOPMENT IN SWITZERLAND. K. Behringer (Eidgenössisches Institut für Reaktorforschung, Würenlingen (Switzerland)). 11p.

Descriptions are given of: gamma-compensated ionization chambers for neutron-flux measurements; instruments for analyzing boiling on reactor fuel element surfaces by frequency analysis of the generated acoustic noise; and monitors of fuel element integrity and water levels. The instruments described are used in the Swiss reactors SAPHIR and DIORIT. (T.F.H.)

24166 (CONF-640607(Vol.I)(Paper B-1)) BORAX V IN-VESSEL INSTRUMENTATION. E. J. Brooks (Argonne National Lab., Idaho Falls, Idaho). 20p.

Instrumentation has been provided on this reactor, with integral superheater, to measure conditions in the boiler and superheater sections. Fluid and fuel temperatures, as well as flow rates and other hydraulic parameters, are measured. (auth)

24167 (CONF-640607(Vol.I)(Paper B-2)) THE DEVELOPMENT OF THE IN-PILE INSTRUMENTATION FOR THE BR3/VULCAIN EXPERIMENT. E. J. Burton, J. Bishop, and D. K. Cartwright (United Kingdom Atomic Energy Authority, Risley (England). [Engineering Group]). 21p.

Instrumentation is to be included within the pressure vessel of the BR3 reactor to help evaluate the performance of the variable-moderation core of the Vulcain concept. The main measurements to be made are those of flux distribution, inlet and outlet coolant temperatures, and local coolant velocity. Routes for the flux measurements are provided by pressure thimbles penetrating the reactor vessel and replacing selected fuel pins within the clusters. Axial distribution of flux is measured by wires containing alloys of dysprosium or manganese. The wires are counted automatically within the containment building. Local measurements of neutron spectrum are obtained from fissile specimens, either UO_2 pellets or uranium or plutonium alloy wires. These specimens enable three ratios to be measured, namely thermal fission, fast fission, and conversion. The counting for these measurements is to be done remotely. Dynamic measurements of flux are to be made with fission chambers directly immersed in the coolant, located at fixed positions in the fuel clusters. Coolant temperatures are measured with stainless-steel-sheathed thermocouples of Chromel–Alumel. The position of the outlet thermocouples is chosen to reduce mixing errors. Calibration is carried out in situ to achieve the highest accuracy. (auth)

24168 (CONF-640607(Vol.I)(Paper B-3)) IN-CORE INSTRUMENTATION OF THE SWEDISH R2-LOOP NO. 2. Jan Falck (Aktiebolaget Atomenergi, Stockholm (Sweden)). 33p.

A forced-circulation, pressurized-water loop is being built in the R-2 reactor. This paper gives a review of the instrumentation planned for the in-pile fuel test section. The instrumentation will mainly include temperature and pressure measurement in the reactor. Coolant temperature will be measured by thermocouples. A special thermocouple wire penetration through the fuel can has to be designed. The experiences gained at the HBWR fuel temperature measurement will then be taken into account. However, the construction of the fuel element may be more complicated than that of the HBWR element because one single fuel rod will contain more than one thermocouple (maximum six). An attempt will be made to have pressure taps in the test section coolant inside the reactor. Two small tubes with the bottom ends designed as pressure probes will be located upstream and downstream of the test section. The penetration out of the test section pressure container is solved by connecting the tubes to slots, sealed by O-rings in the container head. In addition an arrangement for fission-gas pressure measurement is planned. The principle will be the same as used in Halden. (auth)

24169 (CONF-640607(Vol.II)(Paper D-3)) REMARKS ON WATER LEVEL MEASUREMENTS IN DIORIT. H. Flury (Eidgenössisches Institut fllr Reaktorforschung, Würenlingen (Switzerland)). 5p.

The description and operation of the three water-level indicators in Diorit are given. These systems are: a sight glass mounted outside the reactor shield; a helium bubble system; and a float in the tank. The last two of these indicate the level in the control room. Diorit is a heavy-water-moderated and -cooled, 20-Mw(t), materials testing reactor. (T.F.H.)

24170 (CONF-640607(Vol.II)(Paper F-1)) FAILURE DETECTION IN DIORIT. H. Flury (Eidenösoisches Institut für Reaktorforschung, Würenlingen (Switzerland)). 8p.

The burst-fuel-element detection system for Diorit reactor is described. The system extracts fission-product Xe and Kr from the reactor coolant, precipitates the Xe and Kr onto electrodes, and measures the gamma activity of the precipitate. Problems encountered in the design and operation of the system are discussed. (T.F.H.)

24171 (HW-84544(App.5)) CALCULATED REACTOR PARAMETERS FOR THE HIGH POWER DENSIT" CORE

IN PRTR. R. I. Smith and J. L. Maryott (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Dec. 3, 1964. Contract AT(45-1)-1350. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The possibility of producing a positive reactivity change in PRTR, with the high power density core in place and with the moderator poisoned with 81 ppM by weight natural boron in D_2O, by injection of helium bubbles does exist. However, the probability of injecting bubbles while operating within operating standards is essentially zero. Also, injection of bubbles with the reactor moderator level in the normal operating range should produce a net loss of reactivity. For these reasons, it can be concluded that no unsafe condition is likely to be created in PRTR due to bubble injection with the moderator poisoned, as long as the moderator temperature remains unchanged. (auth)

24172 (IDO-12039) SPERT I DESTRUCTIVE TEST SERIES ENVIRONMENTAL MONITORING AND RESEARCH STUDIES. D. F. Bunch (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.). Jan. 1965. 83p. $3.00(cy), 2(mn) CFSTI.

The Spert I Destructive Test Program consists of several test series, each of which is terminated by a short-period excursion in which some limited melting or core damage is obtained. One of the major objectives of the series is to investigate the consequences of reactor accidents. The first test of the Destructive Test Series at the Spert I facility (using a highly enriched, uranium–aluminum plate core) had a nuclear energy release of 31 Mw-sec with a period of 3.2 msec. Gross damage occurred to the core, and water was expelled some 25 meters above the vessel. Only daughters of noble gases (^{91}Sr, ^{91}Y, ^{92}Sr, ^{92}Y, and ^{139}Ba) were detected on downwind air samples by gamma spectrometry. An estimated 3.6×10^4 curies of noble gases were released to the atmosphere as a result of this excursion. This amount represents about 7.2 percent of the noble gases which were produced from the excursion and about 0.7 percent of the total fission product inventory. The second test (using a low enrichment UO_2 pin type core) had a nuclear energy release of 155 Mw-sec with a 2.2-msec period. Only slight damage occurred with two fuel pins being ruptured. The release to the atmosphere was about 540 curies, a release fraction of 350 times less than from the first test. Again only daughters of noble gases were detected. This release was about 0.02 percent of the noble gases and 0.002 percent of the total fission product inventory. The third test (using essentially the same core as the second test) had an energy release of 165 Mw-sec with a 1.55-msec period. About 1900 curies of noble gases were released, about 0.06 percent of that produced and 0.006 percent of the total fission product inventory. Based on minimum detection limits of sampling methods, a maximum of 0.01 percent of the iodines produced from each of these tests could have been released to the atmosphere. The fission products that were released from these tests did not create any hazard to personnel or the environment on or off the National Reactor Testing Station. Data from an extensive film dosimeter system indicated maximum doses of about 15 R gamma and 250 Rad beta, 3 meters from the reactor vessel in the first test. At the same locations, doses were 0.6 R gamma and 1.6 Rad beta from the second test and 1.2 R gamma and 1.3 Rad beta from the third test. Studies were conducted with grass samples as well as fallout plates. The average deposition velocities for the first, second, and third test, respectively, were: grass—0.025, 0.033, and 0.042 m/sec; gummed paper fallouts—0.003, 0.005, and 0.004 m/sec. (auth)

24173 (NDL-TR-56) NEUTRON FLUX MEASUREMENTS AT THE DIAMOND ORDNANCE RADIATION FACILITY. David T. Kilminster, Jean Kappes, and John H. McNeilly (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Feb. 1965. 41p.

The threshold detector system was used to measure the neutron flux environment at various points around the DORF-Triga Mark F reactor. A total of two hundred and forty-seven measurements was made in the exposure room and the pool with the reactor in the pulse mode. An additional measurement was made in the exposure room with the reactor in the steady-state mode. The neutron flux was monitored by placing a set of threshold detectors on the upper grid plate of the reactor core during each pulse. (auth)

24174 (NP-14832) ONE AND A HALF YEAR EXPERIENCE WITH THE TSING HUA OPEN-POOL REACTOR (THOR) AND ITS UTILIZATION. (National Tsing Hua Univ., Hsinchu (Taiwan). Inst of Nuclear Science). Dec. 2, 1962. 77p. Dep.(mn).

A description of the Tsing Hua Open-Pool Reactor (THOR) is presented. The calibration experiments for determining the critical core loading of different core configurations, control blade worth calibrations, neutron flux mapping, and reactivity measurements are discussed, and the results are given. The routine operation experience and radiation safety program are discussed. The use of the reactor for radioisotope production and for personnel and student training is also discussed. (C.E.S.)

24175 (NYO-2910-9) APPLICATIONS OF ULTRASONIC ENERGY. ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 21, February 1, 1965–March 31, 1965. (Aeroprojects, Inc., West Chester, Pa.). Apr. 1965. Contract AT(30-1)-2910. 8p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The installation of a molten-salt level indicator in the MSRE fuel processing tank is discussed. Construction and laboratory testing of this instrument have been completed, and the instrument components are ready for installation. (auth)

24176 (ORNL-3780) DEVELOPMENT OF NONDESTRUCTIVE TESTING TECHNIQUES FOR THE HIGH FLUX ISOTOPE REACTOR FUEL ELEMENT. R. W. McClung (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 21p. Dep.; $2.00(cy), 1(mn) CFSTI.

During fabrication development for the High Flux Isotope Reactor fuel element, several nondestructive testing methods were studied, developed, and applied to the evaluation of various properties. The properties tested include determinations of physical dimensions, detection of flaws, and measurement of the quantity and distribution of fuel material within the element and its component parts. These tests were necessary to provide assurance that its performance would be compatible with designers' expectations in extremely high thermal fluxes. The techniques included penetrating radiation methods for measurement of fuel concentration variables within each fuel plate. Eddy-current techniques were used during plate fabrication to provide identification of core orientation, and after assembly into complete fuel elements to measure the coolant channel (plate-to-plate) spacing. Ultrasonics allowed removal of fuel plates containing nonbonds, which would cause premature failure. Each method described was considered to be mandatory to assure the reliability of the fuel element, as a result of its severe operating conditions. (auth)

24177 (ORNL-3781) OPTICAL MAPPING OF OAK RIDGE RESEARCH REACTOR EXPERIMENT TUBES. A. A. Abbatiello (Oak Ridge National Lab., Tenn.). Apr. 1965. Contract W-7405-eng-26. 20p. Dep.; $1.00(cy), 1(mn) CFSTI.

The as-built positions of ten experiment tubes within the Oak Ridge Research Reactor (ORR) pressure vessel were obtained from an overhead bridge above the reactor with optical tooling instruments adapted for vertical viewing. A special mapping tool provided the specific location of experiment tubes with respect to a vertical reference line of sight. A transit capable of moving in X-Y directions mounted on the service bridge formed the reference zero for the vertical line from which the desired surfaces were located. All the required points were fixed in rectangular coordinates and dimensioned from the reactor access flange centerline. Scale plots were made for all experiment tubes at 10-in. elevation levels between the top of the core and the access flange. The results show that most of the tubes occupy their designated areas, but some deviate to an extent that limits available space for future experiments. The optical tooling used in this application with mapping tools and a pentaprism for viewing otherwise in-

accessible regions demonstrated ability to locate points in a high radiation field safely through shield water, acceptable precision (±0.05 in. through 8 ft of water), and rapid manipulation. About 100 data points for the tubes were taken in two 8-hr shifts during a reactor shutdown. This time included the initial instrument setup time. This mapping technique can be applied to reactors (or other equipment) to locate remote surfaces that are either in direct view or whose position can be extended into the line of sight with suitable mapping aids. (auth)

24178 (TID-21726) NORA PROJECT PROGRESS REPORT, DECEMBER 1961–JUNE 1962. Second Report. (Institutt for Atomenergi, Kjeller (Norway)). Contract 104/US. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The NORA reactor was operated during the first part of the report period with the Halden II fuel charge. About midway of the period the core was changed to a 10-cm square lattice of Savannah-type fuel pins and operated with this charge until shutdown near the end of the period. Physics measurements made during the period are discussed. Fabrication and operation of JEEPNIK are discussed. Theoretical programs related to NORA are summarized. (J.R.D.)

24179 MEASUREMENTS IN THE FR 2 REACTOR POISONED BY BORIC ACID. M. Diederichs, H. W. Glauner, H. Graebner, and D. Wintzer (Gesellschaft fur Kernforschung mbH, Karlsruhe, Ger.). Atomkernenergie, 10: 23-32(Jan.-Feb. 1965). (In German)

In FR 2 the excess reactivity of the cold reactor was compensated by adding boron, and neutron flux and reactivity measurements were carried out at low power. Before the tests in the reactor, extensive preliminary tests were made, especially in the field of chemistry. After the measurements, the boron could be completely removed. (auth)

24180 SPECIAL ELEMENTS FOR RESEARCH REACTORS. H. Eschnauer and H. Hassel (Nuklear-Chemie und -Metallurgie mbH., Wolfgang bei Hanau am Main, Ger.). Atomwirtschaft, 10: 134-6(Mar. 1965). (In German)

In addition to fuel elements for the normal operation of research reactors special elements with or without fuel are also necessary in order, for example, to determine the operating conditions of the reactor or to be able to introduce specimens for irradiation into the reactor. Among fuel elements incorporating measuring devices are those necessary for numerous thermal measurements whose element plates are fitted with thermoelements. For flexible experimentation it is necessary that fuel elements with measuring devices have interchangeable fuel plates. The fuel elements meet almost all the specifications for normal operational fuel elements except that the individual fuel plates are secured in a special way. With special tools these can be interchanged under depths of 6 to 8 m of water. It is, however, necessary that the interchangeable plates be fixable with certainty in the fuel housing. Among elements with measuring devices those with arrangements for hydraulic measurements are described. These are required for determining the behavior of the cooling medium both within the element as well as on its surface. The measuring devices must be so thin that they can be introduced into the aluminum of the fuel plates and of the fuel element container. For irradiation experiments plates with capsules or pockets, in which the specimen can be introduced, are used in place of the central fuel plates. (auth)

24181 THE MEASUREMENT OF FAST NEUTRON SPECTRA AT HIGH REACTOR POWERS. F. Boreli, N. Berovic, M. Aleksic, and V. Lazarevic. Bull. Boris Kidrich Inst. Nucl. Sci., 14: 255-8(Oct. 1963).

The fast neutron spectrum ranging from 1 to 6 Mev at the exit aperture of the horizontal channel B of the RA reactor was measured at 2 Mw, using a simple semiconductor counter telescope. (auth)

24182 GRENOBLE NUCLEAR RESEARCH CENTER. Euro Nucl., 2: 93-100(Feb. 1965).

The location, organization, and facilities of the Grenoble Nuclear Research Centre are described, and research on reactor physics, chemistry, physics, isotopes and biology, and metallurgy are summarized. The general structure of the utilities and services of the Centre is presented. (L.B.S.)

24183 COMPARISONS BETWEEN TYPE BR-2 AND TYPE ETR OF MATERIAL TEST REACTORS. Kazuo Nishimura (Meidensha Electric Mfg. Co., Ltd., Japan). Meidensha Jiho, No. 56, 39-43(Aug. 1964). (In Japanese)

The differences between power reactors and materials testing reactors are described, and the cores and structures of the BR-2 and the ETR are compared in view of the installation of a materials testing reactor in the JAERI. The BR-2 is suitable for the installation from the standpoint of nuclear safety, but has some disadvantages with respect to economy and life. (NSA of Japan)

24184 EXPERIMENTAL FACILITIES AT PAKISTAN RESEARCH REACTOR (PARR). Muhammad Shafique. Nucleus (Lahore), 1: No. 4, 25-7(Oct.-Dec. 1964).

A description is given of the water-cooled, water-moderated PARR reactor, which is designed for research experiments, production of radioisotopes, and training of personnel. The experimental facilities consist of six beam tubes, a through tube, a vertical tube, a thermal column, three independent pneumatic rabbit systems, a hot cell, and a dry gamma irradiation facility. (L.B.S.)

24185 USE OF FILTERS FOR MEASURING THE RATIOS OF REACTOR EMISSION COMPONENTS. Ya. Zh. Kristapson, K. K. Shvarts, and K. K. Baltmugur (Inst. of Physics, Academy of Sciences, Latvian SSR). p.71-7 of "Radiatsionnaya Fizika. II. Dosimetriya Neitronov i Gamma-Luchei." Riga, Izdatel'stvo Akademii Nauk Latviiskoi SSR, 1964. (In Russian)

Descriptions are given of the design and performance of a reactor channel designed with six filters for differentiating the IRT reactor emission components. The channel was designed with six filter openings: distributed around the rotor. The filter-holding facility was controlled from the second story reactor mechanism. Five of the openings were fitted with filter filled steel containers with tightly fitted aluminum covers. The sixth opening was left empty to emit constant unchanged reactor radiation. Boron and cadmium filters were used for attenuating thermal neutrons and lead filters for attenuating γ rays. The variations in the reactor filter flux and dose emission (at reactor operations of 1000 kw) are tabulated and analyzed. The experiments achieved effective partition of complex reactor emission into separate components was used in experiments with luminescence and radiation in ion crystal damage. (R.V.J.)

24186 SHORT INTERVAL SERIES PULSING WITH TRIGA REACTOR. G. H. Miley, H. A. Kurstadt, and G. P. Beck (Univ. of Illinois, Urbana). 4p. (CONF-654-60).

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

Typical results of peak power, excess reactivity, and fuel temperature measurements involving repetitive pulsing of a Triga Mark II reactor with time intervals of 20 to 120 sec between pulses are summarized, and a model developed for calculating the fuel element temperature rise and the excess reactivity is outlined. (D.C.W.)

24187 EXPERIMENTAL DETERMINATION OF THE ISOTHERMAL TEMPERATURE COEFFICIENTS OF REACTIVITY AND TEMPERATURE DEPENDENT THERMAL DISADVANTAGE FACTORS OF THE CORNELL UNIVERSITY ZERO POWER REACTOR. W. P. Wynn, Jr. (Cornell Univ., Ithaca, N. Y.). 121p. (CONF-654-76)

From American Nuclear Society Meeting, San Francisco, Nov.-Dec. 1964.

A comparison between experiment and theory was made for two-temperature dependence studies on the Cornell University Zero Power Reactor; a light water moderated, 2.1% enriched, UO_2 ceramic fueled, aluminum clad, triangular pitched critical assembly with nominal water-to-fuel ratios of 1:1, 1.5:1, 2:1, 3:1, and 4:1. The isothermal temperature coefficient of reactivity was calculated using

two-group, two-region perturbation theory for an infinite cylinder. The temperature coefficient was predicted to be a linear function of the volumetric coefficient of thermal expansion for water, with intercept A and slope B. For four water-to-fuel ratios, excess reactivity was determined as a function of temperature from clean-core period measurements converted by the inhour equation. Reactivity differences were divided by temperature differences to obtain the isothermal temperature coefficient of reactivity. Values of the temperature coefficient were least-squares fitted to linear functions of the coefficient of expansion of water to determine A and B. Disagreement between measured and calculated values of A and B indicates a need for refinement of the calculations. Thermal disadvantage factors were measured over a temperature range from 5 to 65°C for three water-to-fuel ratios using dysprosium, manganese, and vanadium foils. Two integral foil counting techniques were used. One was to dissolve the manganese foils in nitric acid and gamma-count aliquots of the solutions in a well-type scintillation counter. The other method was to beta-count the solid foils in a proportional flow counter. Results of the two methods agreed within experimental error. Measured values of thermal disadvantage factors were compared to theory and found to be a few per cent low. Further experimental studies are suggested to investigated the disagreement. Thermal disadvantage factors were least-squares fitted to a linear function of temperature to determine the temperature dependence. Measured and calculated values of the temperature dependence were found to agree within the experimental errors. (auth)

24188 PULSTAR—A NEW SOURCE FOR PULSED NEUTRON AND GAMMA IRRADIATION. William F. Hall (Western New York Nuclear Research Center, Inc., Buffalo), Ralph F. Lumb, and John MacPhee. 8p. (CONF-641009-12)

From Joint American Nuclear Society and American Society for Testing Materials Conference on Radiation Effects on Electronics, Syracuse, N. Y.

A reactor is described, which will provide a pulse of 10,000-Mw peak powers with a period of 1.9 msec and a pulse width of half-height of 6.45 msec. The main mechanism permitting pulsing to high power levels in the increased neutron capture, due to Doppler broadening, in the ^{238}U as the fuel temperature rises. (D.C.W.)

24189 A MATERIAL TEST NUCLEAR REACTOR. (to Hitachi Ltd.). British Patent 981,668. Jan. 27, 1965. Priority date Sept. 12, 1962, Japan.

In order to obtain reduced γ heating and reduced change of reactivity of the reactor core caused by insertion of a test piece, the reactor patented employs a mixture of light water and heavy water as the moderator. The mixing ratio is maintained at a preset value (preferably 20-40 vol % of light water) during operation of the reactor, but may be changed between operations. (A.G.W.)

WASTE DISPOSAL AND PROCESSING

See also BIOLOGY AND MEDICINE — Ecology.
CHEMISTRY — Radiochemistry.
CHEMISTRY — Separation Processes and Procedures.
HEALTH AND SAFETY.

Refer also to abstracts 21791, 22405, 22529, and 24065.

24190 (HW-77274) BURIAL OF HANFORD RADIOACTIVE WASTES. G. E. Backman, P. C. Jerman, R. E. Roberts, and J. W. Vanderbeek (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 15, 1963. Contract AT(45-1)-1350. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The current policies and procedures and future plans of Hanford relative to the disposal of solid radioactive waste are reported. The feasibility and practicability of burial ground consolidation are discussed and maps are included that indicate the location of both active and retired burial grounds. (P.C.H.)

24191 (TID-21786) [AN ECONOMIC STUDY OF THE C.E.N. RADIOACTIVE WASTE TREATMENT PLANT.] (Division of International Affairs (AEC), Washington, D. C.). [nd]. Contract AT(30-1)-3348. 68p. Dep.(mn); $3.00(cy), 2(mn) CFSTI.

Economics of the C.E.N. waste treatment plant, which handles the radioactive wastes originating in the operation of the C.E.N. reactors and laboratories, the Eurochemic plant, and the Euratom laboratories, are given. Waste treatments, concentrated waste storage, and ultimate treated waste disposal are included. Data on activities and monthly running expenses are tabulated. (P.C.H.)

24192 THE EUROCHEMIC REPROCESSING PLANT AT MOL. PART II. R. O. Brooks. Euro Nucl., 2: 85-7(Feb. 1965).

A description is given of the treatment of effluent, storage of high level waste, general services building, research laboratory pilot hall, and health and safety program at the Eurochemic reprocessing plant. (L.B.S.)

24193 DILUTION OF RADIOACTIVE EFFLUENTS IN A SLOW-MOVING RECIPIENT. S. Bergstroem (Aktiebolaget Atomenergi, Stockholm). Euro Nucl., 2: 129-33(Mar. 1965).

The active waste release situation at the Ågesta Heat and Power Station is described. The use of high-velocity jet release of the low-level waste in Lake Magelungen as a result of water court verdicts and the recipient characteristics is discussed. Mass transfer and concentration reduction in round symmetrical jets are considered against the background of theoretical and experimental knowledge. Results from experiments made at Studsvik are quoted and equipment described. (auth)

24194 REMOVAL OF RADIOACTIVE SUBSTANCES BY KOREAN ACID CLAY. Noriyuki Mishio and Sho-ou Tcho (Ebara Mfg. Co., Ltd., Japan). Genshiryoku Kogyo, 10: No. 4, 34-7(Apr. 1964). (In Japanese)

Four kinds of acid clay from the Kyung-buk district in Korea were used as samples. The main components of these samples were found by x-ray and spectroscopic examination to be montmorillonite, zeolite, and quartz. After adding 1,000 ppm acid clay to a pseudo-waste solution of ^{137}Cs and ^{89}Sr (ca 10^{-2} $\mu C/ml$) and stirring for 30 min, the sample solution was allowed to stand for 30 min and the supernatant was taken out to measure the radioactivity. In general, baking of the samples lowers the decontamination ratio. The existence of $NaNO_3$ does not affect the decontamination of ^{137}Cs to a great extent; the decontamination of ^{89}Sr is, however, likely to be influenced by the existence of Na^+ and the decontamination ratio decreases appreciably. A pH value of 4−11 is suitable. In the treatment of actual waste solutions (5×10^{-6} C/ml), about 80% decontamination ratio was obtained. (NSA of Japan)

24195 OPTIMALIZATION OF SIZE AND PERFORMANCE OF AN EVAPORATOR. H. Mende. Kerntechnik, 7: 182-4(Apr. 1965). (In German)

The operating expenses of a directly heated decontamination evaporator are higher than those of a forced-circulation evaporator with electrically driven compressor. Only if the annual operating time is very short and capital costs are taken into consideration as percentage of investments in the distillate price can a small quantity of distillate be produced economically by a directly heated evaporator. By means of diagrams and examples the efficiency of a small continually working evaporator is compared with that of a bigger intermittedly working evaporator producing the same quantity of distillate per year. (auth)

24196 BIOLOGICAL TREATMENT OF RADIOACTIVE WASTE WATER. Masaharu Imaoka (Inst. of Public Health, Tokyo). Koshu Eiseiin Kenkyu Hokoku, 13: 90-5(June 1964). (In Japanese)

Literature data indicated that the biological treatment methods for municipal sewage, such as activated sludge processes, trickling filters, and oxidation ponds, are applicable to radioactive wastewater. In order to confirm the applicability of the conventional methods to radioactive wastewater, an activated sludge experiment was conducted to see whether the sludge organisms suffer any harm in radioactive water and whether they decontaminate radioactivity. Two samples were placed each in a one liter aeration bottle; one was non-radioactive for control, and the other was radioactive with ^{32}P. Sewage and activated sludge were obtained from a municipal sewage treatment plant. Every day, new sewage and ^{32}P were added after the end of aeration and the sewage was left standing for about thirty minutes, then 800 ml of the supernatant were discarded. Five ml of the centrifuged supernatant were dried on a stainless steel planchet under an infrared lamp and the radioactivity was counted with a G-M counter. Sorption of ^{32}P by the sludge was observed. The radioactivity in the sludge increased day by day. The removal rate of ^{32}P was found to range from 46 to 90%. The total numbers of microorganisms in the sludge in both samples were counted and compared. In short term and at such low levels of ^{32}P as 0.3 to 0.9 $\mu C/l$, the activated sludge organisms were found to suffer no harm from the radioactivity of ^{32}P concentrated in the sludge. (auth)

24197 TREATMENT OF RADIOACTIVE WASTE WATER WITH ACTIVATED SLUDGE. Masaharu Imaoka (Inst. of Public Health, Tokyo). Koshu Eiselin Kenkyu Hokoku, 13: 96-104(June 1964).

Treating low-level radioactive waste water together with municipal sewage by biological methods is thought to be effective and economical. If no suitable sewage is available, some other nutrients may be added to radioactive waste water. Some experiments were carried out with nutrients such as flour, glucose, and dried sludge from night soil digestion tanks to see if good sludge could be obtained. The test plant consisted of an aeration tank with a capacity of 1 m^3; a settling tank, 0.3 m^3; a reaeration tank or sludge oxidation tank, 1 m^3; and a spare tank, 0.3 m^3. Some test operations were carried out with these nutrients mixed with tap water. First, 3 parts in weight of dried sludge and 1 part of glucose were added as nutrients. When seeded with return sludge from a municipal sewage treatment plant, good activated sludge having very good settle-

ability was obtained. Then dried sludge was substituted with flour to decrease the content of phosphorus in the test plant, and the settleability of the activated sludge became slightly poorer, because dried sludge seemed to contain too much phosphate as nutrient to remove ^{32}P. Removal and holding tests of activated sludge from the test plant and a municipal sewage treatment plant were made in 1-liter aeration bottles. In the first half of the test period, every 24 hr, 500 ml of the supernatant was discarded after 0.5 to 3 hr of standing and fresh artificially radioactive waste water (tap water containing radioactive material and nutrients) was filled in the same amount. In the second half of the test period, aeration was stopped for 0.5 to 3 hr for sampling, and instead of discarding the supernatant, the equivalent amount of the radioactive material was added with or without the equivalent amounts of the nutrients. In some cases, only water was supplemented without adding the radioactive material and the nutrients, and sampling was repeated. Samples were dried on stainless planchets and counted with a G-M counter. More than 99% of ^{32}P was found to be removed from the nutrition-dosed waste water when phosphorus was deficient. As for ^{89}Sr, a better result was obtained with the higher content of dried sludge in the test bottle that contained much phosphorus. Phosphorus-32 and ^{89}Sr were held in the sludge for 2 or 3 weeks, and the radioactive-material removability of the sludges was also found to be kept good for some 2 weeks if the nutrients added and other conditions were suitable. (Public Health Eng. Abstr., 45: Feb.-Mar. 1965)

24198 WASTE DISPOSAL. Reactor Fuel Process., 8: No. 1, 37-49(Winter 1964-65).

A review is presented on waste disposal methods, including management of tritium in fuel-processing wastes, ion exchange of liquid wastes, conversion of high- and intermediate-level-activity wastes to solids, and recovery of strontium from Purex-waste tank sludge. (P.C.H.)

GENERAL AND MISCELLANEOUS

24199 (BNL-867) ANNUAL REPORT, JULY 1, 1964. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. 246p. Dep.; $6.00(cy), 4(mn) CFSTI.

Research and development are reported in sections on physical sciences and engineering, life sciences, and supporting activities. Separate abstracts were prepared for these sections. Information concerning publications and the laboratory staff are contained in appendices of the report. (J.R.D.)

For abstracts of individual sections see: 21817, 23355, and 24200.

24200 (BNL-867(p.151-78)) SUPPORTING ACTIVITIES. (Brookhaven National Lab., Upton, N. Y.).

The technical services and facilities provided for the Laboratory are described. Information is included on reactor operations, health physics, mechanical engineering, machine shop services, technical information, and photographic and graphic art services. (J.R.D.)

24201 (COO-1148-95) POLAROGRAPHIC REDUCTION OF ADENINE 1-N-OXIDE. Charles R. Warner and Philip J. Elving (Michigan Univ., Ann Arbor). Feb. 27, 1965. Contract AT(11-1)-1148. 24p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Adenine 1-N-oxide gives a fundamental pattern of three polarographic waves over the pH range of 1.4 to 5.6; above pH 6, the pattern is obscured by the prior background discharge. The first wave, which arises from the two-electron reduction of the N-oxide to adenine, is pH-dependent; the shape of the wave is distorted by the marked decrease in its slope with increasing pH, until at about pH 4, it is difficult to distinguish between it and the next wave. The second wave, which shows a pH-dependence and general behavior identical to those of adenine itself, is due to the further six-electron reduction of adenine, probably to an aminoimidazole, plus some reduction of hydrogen ion through a catalytic process involving one or more of the adenine species and their reduction products. The third wave is due to a catalytic hydrogen evolution, which again involves the adenine species and their reduction products. (auth)

24202 (HW-SA-3511) THE INFLUENCE OF GREASEWOOD ON SOIL MOISTURE PENETRATION AND SOIL CHEMISTRY. W. H. Rickard (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). [Apr. 30, 1964]. Contract AT(45-1)-1350. 11p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Soil properties were studied in a greasewood (Sarcobatus vermiculatus) stand on the Hanford Reservation. Greasewood shrubs increase exchangeable sodium, potassium, and pH of soil beneath their canopies. The pattern of soil pH corresponded generally to the outline of shrub canopies. The circular pattern of shrub canopy and the pattern of pH was skewed to the east or downwind side of the shrubs. An irregular zonal distribution of pH with soil depth was also observed with maximal pH values confined to the eastern side of the shrubs. Soil moisture penetration in winter was less deep beneath shrub canopies than in adjacent inter-shrub areas. About one-fifth of the moisture available for soil moisture replenishment was intercepted by shrub canopies and litter. Soil moisture penetrated less deeply on the eastern sides of the shrubs. (auth)

24203 (IS-T-4) AN ELECTRON DIFFRACTION INVESTIGATION OF PHOSPHORUS PENTAFLUORIDE AND METHYLTETRAFLUOROPHOSPHORANE (thesis). Kathryn Wirth Hansen (Ames Lab., Iowa State Univ. of Science and Tech.). Feb. 1965. Contract W-7405-eng-82. 50p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

An electron diffraction study was made on PF_5 and PF_4CH_3, including a review of the theories concerning their stereochemistry. A correlation of theoretical and experimental structures was made. The results showed that the experimentally determined structures for PF_5 and PF_4CH_3 agree with the theoretical formulations given. It was noted that the equatorial and axial distances are both longer in PF_4CH_3 than in PF_5. The equatorials are 0.009 Å longer and the axials 0.035 Å. This may be caused in part by the repulsions of the methyl group. Since the axial fluorines are closer to the methyl group than are the equatorial, it is expected that the axial distances would show the greater difference. The P-C distance is also shorter in PF_4CH_3. This is presumably due to the highly electronegative fluorine atoms connected to the phosphorus. (P.C.H.)

24204 (JUL-Bibl-7) LITERATURZUSAMMENSTELLUNGEN AUS DEN GEBIETEN DEN KERNWISSENSCHAFTEN. (Literature Compilations from the Area of Nuclear Science). M. Wittenberg, comp. (Kernforschungsanlage, Julich (West Germany)). Oct. 1964. 12p. Dep.(mn).

The titles of the bibliographic searches made by the central library of the nuclear research installation at Julich are tabulated. The arrangement of the titles follows the classification of Nuclear Science Abstracts. (J.S.R.)

24205 (LA-3243) ROCK MELTING AS A DRILLING TECHNIQUE. Dale E. Armstrong, James S. Coleman, B. B. McInteer, Robert M. Potter, and Eugene S. Robinson (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 1962. Contract W-7405-eng-36. 36p. Dep.; $2.00 (cy), 1(mn) CFSTI.

Rocks melt rapidly in contact with tungsten or molybdenum heated electrically to incandescence. The metals exhibit excellent strength and resistance to corrosion. Drills applying these observations were constructed and tested with continuous removal of the lava. The hydrodynamics of molten rock moving beneath a drill is presented. Appropriate lines for additional developmental work are suggested. (auth)

24206 (LADC-6449) A DIGITIZED COMPARATOR FOR KARYOTYPE ANALYSIS. P. M. LaBauve, R. J. LaBauve, and D. F. Petersen (Los Alamos Scientific Lab., Univ. of California, N. Mex.). [1963]. Contract [W-7405-eng-36]. 15p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

In recent years, refinements in techniques for in vitro culture and cytological preparation have made possible accurate enumeration and evaluation of the chromosome complements of many mammalian species, including man. Results are reported from a study undertaken to determine the feasibility of using automated equipment and methods for chromosome analysis. The application of these methods, with the resultant saving of time and labor, appears to be worthwhile. In the classification of chromosomes, it is essential to know the relative lengths and the ratio of the lengths of the long and short arms. These parameters are routinely determined by making linear measurements on photographic enlargements of several carefully selected and well spread metaphase figures. The calculations are then made by hand. This onerous and time-consuming task can be considerably lightened by the use of a digitized comparator to obtain the initial linear measurements on punched cards so that the calculations can be performed by a high-speed electronic computer. (auth)

24207 (PAEC(A)IN-643) NUCLEAR ENERGY IN THE PHILIPPINES. An Annotated Bibliography. (Philippine Atomic Energy Commission, Manila). Oct. 1964. 26p. Dep.(mn).

Sixty-one references on nuclear science research in the Philippines are given to journals and reports published from 1959 to 1964. Brief abstracts are given for each reference. Separate author and subject indexes are included. (P.C.H.)

24208 (PNE-449) SLOPE MOVEMENT INVESTIGATIONS IN SUPPORT OF PROJECT CHARIOT IN THE VICINITY OF CAPE THOMPSON, NORTHWESTERN ALASKA. Progress Report, August 1–December 31, 1960.

K. R. Everett (Ohio Agricultural Experiment Station, Wooster and Ohio State Univ., Columbus. Inst. of Polar Studies). Contracts AT(11-1)-1010 and AT(11-1)-414. 25p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Slope movement and the contemporaneous physical state of the soil in various slope situations and in various solifluction features was recorded in the vicinity of Cape Thompson, northwestern Alaska during the summer of 1960. Solifluction feature was used to encompass all micro-relief resulting from movements within the active layer. Instruments were installed and observations were made into the freeze-up of 1960, which occurred in Sept. The data gathered and analyzed thus far are insufficient for any general conclusions. They do, however, indicate the roles of temperature, soil moisture, and soil movement. (P.C.H.)

24209 (PNE-451) SLOPE MOVEMENT INVESTIGATIONS IN THE OGOTORUK CREEK VALLEY. Project Chariot, Phase IV Preliminary Report, August 1960–December 1961. K. R. Everett (Ohio State Univ., Columbus. Inst. of Polar Studies). Jan. 1962. Contract AT(11-1)-1010. 26p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

Results on measurements on slope movement in the Ogotoruk Creek Valley during freeze-up in 1960, thaw in 1961, and freeze-up in 1961 are presented. The instruments used for the measurements are described. The results showed that the rate of freezing and thaw line penetration is primarily dependent upon air temperature. The rate of uplift in a scar depends upon the rate and completeness of the conversion of soil moisture from the liquid to the solid state, and the amount of uplift is independent upon the type of ice formed that is related to the moisture content and texture of the soil. The amount of downslope movement resulting from the freezing and heaving of the frost scars is dependent upon the angle of slope and the rate of penetration of the freezing line in the bordering peat ridge. Landslides occur within the valley but are apparently restricted to the wetter, vegetated slopes of more than 25°. Several conclusions were also made on mass-movements. (P.C.H.)

24210 (PNE-452) SLOPE MOVEMENT AND MICRO-ENVIRONMENT AT CAPE THOMPSON, ALASKA. Project Chariot, Phase IV Final Report, December 1961–March 1962. K. R. Everett (Ohio State Univ. Research Foundation, Columbus). Sept. 14, 1962. Contract AT(11-1)-1010. 4p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

Data are summarized from a geological survey of the Ogotoruk Creek valley, near Cape Thompson, Alaska. Some information on plant ecology in the area is included. (C.H.)

24211 (PNE-474) MICROCLIMATOLOGY OF THE CHARIOT SITE. Interim Report No. 1. Philip W. Allen (Weather Bureau Research Station, Las Vegas, Nev.). June 1, 1960. Includes Appendix: CLIMATE OF NORTHWESTERN ALASKA. Robert O. Weedfall. Project Chariot. 13p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A brief discussion is given of the usefulness and scope of the data to be taken in the study of the micrometeorology of the Chariot area. The features of the area which influence the microclimate are reviewed generally. Some data taken since Sept. 1, 1959, are tabulated. A summary of the large-scale climatology of the area is also included. (D.L.C.)

24212 (PNE-477) AIR TRAJECTORIES FROM CAPE THOMPSON DURING SUMMER 1960. Preliminary Report No. 1, December 15, 1961. Philip W. Allen and Robert O. Weedfall (Weather Bureau Research Station, Las Vegas, Nev.). Project Chariot. 17p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

The map of northwestern Alaska was divided into sectors with Cape Thompson at the origin. The daily charts for the levels of 850, 700, and 500 mb in June to August 1960 were given a streamline analysis. The results show that once simultaneous flow at all four levels is going into one sector, it stays established for 2 to 3 days, and when it ends, there is an average wait of 2 to 3 weeks before it swings back into the same sector again. The surface flow is weaker than that aloft. The possibility of a land-sea breeze effect in the light summer flow was studied. (D.L.C.)

24213 (SCL-TM-64-110) DYNAMIC ANALYSIS OF LUMPED MASS SYSTEMS. B. C. Ellis and V. Gabrielson (Sandia Corp., Albuquerque, N. Mex.). Apr. 1965. Contract AT(29-1)-789. 43p. Dep.(mn); $2.00(cy), 1(mn) CFSTI.

The description of complicated systems with arbitrary nonlinearities and inputs through the use of large lumped mass models has become possible with modern computer capability. This report describes the ground work required for using the SHOCK code as a tool for solving these types of problems. The report consists of the derivation of the equation of motions, how these equations are evaluated within the code, and some examples comparing the results obtained by analytical methods to those obtained by computer calculations. (auth)

24214 (TID-3728) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE ISSUED OR IN PROGRESS DURING THE PERIOD, FEBRUARY–MARCH 1965. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 17p. Free(DTI Extension).

Ninety-eight references on bibliographies issued or in progress during Feb.-March 1965 are given. Author, subject, and report number indexes are included. (P.C.H.)

24215 (UCRL-7780) A DRYING CHAMBER FOR RAPID-ACCESS FILM PROCESSING. Fred W. Buys (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 24, 1964. Contract W-7405-eng-48. 9p. Dep.(mn); $1.00(cy), 1(mn) CFSTI.

A drying chamber designed for use with rapid-access film processors is described. The objective of the device is to achieve an intensive, accelerated drying effect upon wet film while in continuous transit through an essentially closed chamber of small dimensions. In the chamber, the film is subjected to a significant reduction in gas pressure. The pressure difference is sufficient to create a jet stream which, in turn, can be heated, rendered turbulent to a degree and constrained to exert upon an emulsion surface a controllable, sustained pressure gradient. Dimensions of the dryer box are given. (P.C.H.)

24216 NUCLEAR ENERGY IN WORLD ENERGY SUPPLIES. K.-D. Fischer (Universitat, Cologne). Atomwirtschaft, 10: 115-18(Mar. 1965). (In German)

An attempt by Bhabha at the Third Geneva Conference to determine the development tendencies in the world use of energy is discussed. He divided the world into nine large regions and into three groups with clearly differentiated energy utilizations: the USA with a use per capita of almost 8 tons coal equivalent, then Europe, the Soviet Union, and Australia with 3 tons, and finally all other regions with less than 1 ton. Since the present developing countries with their low utilization will, during the next decades, strive to catch up, Bhabha anticipated a growing share by these countries in world energy use and hence a further strong increase in energy demand. The reliability of a prediction extending to the year 2000 and the assumption that the present developing countries will attain during the next decades a use of 3 tons per head are considered. It was concluded that the prospects for nuclear energy, however, depend not only on energy demands but also on the economically usable deposits of conventional energy, which will be a determining factor in the price situation. (auth)

24217 ANNUAL REPORT TO CONGRESS OF THE ATOMIC ENERGY COMMISSION FOR 1964. 89th Congress, 1st Session—Senate Document No. 8. (Atomic Energy Commission, Washington, D. C.). Jan. 1965. 448p. (GPO).

The 1964 programs are reviewed under the headings: raw materials, production, military applications, reactor projects, civilian nuclear power reactor program, desalination studies, maritime program, space applications, SNAP terrestrial and marine applications, military reactor programs, advanced reactor technology, nuclear safety research, Plowshare program, radioisotopes

development, international activities, biology and medicine, physical research, education and training, technical information programs, industrial participation, industrial relations, operational safety, contracting policy, classification and declassification, public information program, patents, nuclear materials management, and regulatory activities. (M.C.G.)

24218 ATOMS FOR PEACE CONFERENCE, 1964. THIRD UNITED NATIONS INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, GENEVA, SWITZERLAND, AUGUST 31–SEPTEMBER 9, 1964. (Atomic Energy Commission, Washington, D. C.). 142p. CONF-497. $1.00(GPO).

Information is included on the structure and theme of the conference, the U. S. scientific papers program, the U. S. exhibit program, and U. S. ancillary programs, such as technical information and technical films. Abstracts of papers presented by U. S. delegates are appended. (P.C.H.)

24219 NUCLEAR EDUCATION IN THE NEW ERA OF NUCLEAR POWER. Philip Mullenbach (Growth Industry Shares, Inc., Chicago). 15p. (CONF-714-5)

From Conference on Nuclear Education in the New Era of Nuclear Power, Gatlinburg, Tenn., Aug. 1964.

Changes in the status of nuclear power in relation to conventional power since 1954 are reviewed. Developments in nuclear-power technology, in the economics of nuclear power, and in federal policy towards nuclear-power development are surveyed. Possible implications of the current situation for the policies of government, industry, and education are discussed. (M.J.T.)

24220 STATUS OF THE UNITED STATES URANIUM INDUSTRY. John T. Sherman (Atomic Industrial Forum, Inc., New York). 9p. (CONF-718-4)

From American Institute of Chemical Engineers Meeting, Las Vegas, Nev., Sept. 1964.

The history, present status, and future of the uranium industry are discussed. Fuel ownership, uranium reserves, and estimated uranium requirements are considered. (M.C.G.)

24221 ATOMIC INDUSTRIAL FORUM, 1964 ANNUAL CONFERENCE, NOVEMBER 30–DECEMBER 3, 1964, SAN FRANCISCO, CALIFORNIA, PROCEEDINGS. VOLUME 2. THE STATE OF THE INDUSTRY—1964. A PRIVATE NUCLEAR POWER ECONOMY. THE PRICE-ANDERSON LAW AND SAFETY. Robert N. Udell, ed. New York, Atomic Industrial Forum, Inc., 1965. p.77-144. (CONF-641112 (Vol.2)) $6.00.

Part of the proceedings of the Atomic Industrial Forum's Eleventh Annual Conference are presented. Topics covered include: the atom, catalyst for a 4-mill kwh; costs of enriching uranium in private facilities; European views on toll enrichment, economic and technological aspects of plutonium as a fuel, uranium reserves for nuclear power, the Price-Anderson law, and accomplishments in reactor safety research. (M.C.G.)

24222 FLUIDIZED BED REACTOR. Richard M. Edwards, Sheldon N. Robinson, and Eugene F. Sanders (to U. S. Atomic Energy Commission). U. S. Patent 3,174,834. Mar. 23, 1965.

A fluidized-bed reactor is described. It has a plurality of elongated vertical heaters of different heights, each of which has a conical top. (AEC)

24223 HIGH VOLTAGE ELECTRIC GENERATOR. Cyril D. Curtis (to U. S. Atomic Energy Commission). U. S. Patent 3,175,104. Mar. 23, 1965.

An electric generator is described, which is composed of a variable capacitor with means for cyclically varying the capacitance thereof and a plurality of fixed capacitors. Means are provided for applying an initial charge to a least one of the capacitors and for discharging the variable capacitor into the fixed capacitors responsive to the cyclically varying capacitance of the variable capacitor. Means are also provided for parallel connection of the plurality of capacitors across the variable capacitor, so that the plurality of capacitors discharge into the variable capacitor and the charging of the variable capacitor is increased. The output of the generator is taken across the variable capacitor. (AEC)

24224 TREATMENT OF ALUMINUM SURFACES. Carl A. Burgess and John D. Schaffer (to U. S. Atomic Energy Commission). U. S. Patent 3,175,931. Mar. 30, 1965.

A process and a solution were developed for the surface treatment of articles of aluminum or aluminum alloys with an aqueous solution of alkali metasilicate (20 to 24 oz/gal H_2O) with or without trialkali orthophosphate and subsequent drying of the coating. (AEC)

24225 COPPER METALLIZING OF ALUMINA CERAMICS. Robert E. Cowan (to U. S. Atomic Energy Commission). U. S. Patent 3,180,756. Apr. 27, 1965.

A method was developed for producing a copper coating on an alumina ceramic by applying a near-eutectic mixture of Cu_2O and Al_2O_3 to the surface of the alumina ceramic, firing the resulting article in an oxidizing atmosphere to a temperature above about 1190°C, and subsequently firing in a reducing atmosphere above about 1000°C thereby forming an adherent copper layer on the ceramic surface. (AEC)

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This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium — isotopes He-4 or Helium — He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid — methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium — allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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SWITZERLAND

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28	19-22260	ORINS. Gmelin, AED-CONF-64-155-24
34	19-22281	See BNL-8195
36	19-22158	See BNL-8385
38	19-23814	ORINS. Gmelin, AED-CONF-64-155-49
CONF-617-	**(Special Technical Conference on Nuclear Radiation Effects, Seattle, Wash., July 1964)**	
19	19-22816	ORINS. Gmelin, AED-CONF-64-116-36
20	19-22817	ORINS. Gmelin, AED-CONF-64-116-37
CONF-642-	**(Health Physics Society, Cincinnati, June 1964)**	
29	19-22014	See HW-SA-3338
CONF-651-	**(9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug. 31–Sept. 4, 1964)**	
57	19-23593	ORINS. Gmelin, AED-CONF-64-140-91
74	19-23591	ORINS. Gmelin, AED-CONF-64-140-61
84	19-23989	ORINS. Gmelin, AED-CONF-64-140-100
85	19-23990	ORINS. Gmelin, AED-CONF-64-140-82
86	19-23592	ORINS. Gmelin, AED-CONF-64-140-108
87	19-23987	ORINS. Gmelin, AED-CONF-64-140-110
CONF-654-	**19-2907 19-6030**	**(American Nuclear Society Meeting, San Francisco, Nov. 30–Dec. 3, 1964) Proceedings**
43	19-24129	ORINS. Gmelin, AED-CONF-64-219-20
46	19-23948	ORINS. Gmelin, AED-CONF-64-219-19
47	19-23951	ORINS. Gmelin, AED-CONF-64-219-14
48	19-24156	ORINS. Gmelin, AED-CONF-64-219-13
57	19-24131	ORINS. Gmelin, AED-CONF-64-219-71
58	19-24136	ORINS. Gmelin, AED-CONF-64-219-73
60	19-24186	ORINS. Gmelin, AED-CONF-64-219-38
61	19-23618	ORINS. Gmelin, AED-CONF-64-219-40
62	19-24135	ORINS. Gmelin, AED-CONF-64-219-36
63	19-23354	ORINS. Gmelin, AED-CONF-64-219-37
64	19-24130	ORINS. Gmelin, AED-CONF-64-219-61
65	19-24132	ORINS. Gmelin, AED-CONF-64-219-57
66	19-24046	ORINS. Gmelin, AED-CONF-64-219-56
67	19-21990	ORINS. Gmelin, AED-CONF-64-219-54
68	19-24042	ORINS. Gmelin, AED-CONF-64-219-53
69	19-24041	ORINS. Gmelin, AED-CONF-64-219-43
70	19-23161	ORINS. Gmelin, AED-CONF-64-219-47
71	19-22502	ORINS. Gmelin, AED-CONF-64-219-48
73	19-23115	ORINS. Gmelin, AED-CONF-64-219-30
74	19-24043	ORINS. Gmelin, AED-CONF-64-219-33
76	19-24187	ORINS. Gmelin, AED-CONF-64-219-66
77	19-22801	ORINS. Gmelin, AED-CONF-64-219-89
79	19-24133	ORINS. Gmelin, AED-CONF-64-219-76
82	19-24140	ORINS. Gmelin, AED-CONF-64-219-81
84	19-22953	ORINS. Gmelin, AED-CONF-64-219-68
85	19-22803	ORINS. Gmelin, AED-CONF-64-219-70
86	19-24002	ORINS. Gmelin, AED-CONF-64-219-85
87	19-22804	ORINS. Gmelin, AED-CONF-64-219-96
CONF-691-	**(Conference on Fusion of Body-Centered Cubic-Materials, Gatlinburg, Tenn., Sept. 1964)**	
7	19-23112	ORINS. Gmelin, AED-CONF-64-154-4
8	19-23114	ORINS. Gmelin, AED-CONF-64-154-3
CONF-714-	**(Conference on Nuclear Education in the New Era of Nuclear Power, Gatlinburg, Tenn., Aug. 24–25, 1964)**	
5	19-24219	ORINS. Gmelin, AED-CONF-64-144-5
CONF-715-	**(13th Annual Conference on Applications of X-Ray Analysis, Denver, Aug. 12–14, 1964)**	
8	19-23111	ORINS. Gmelin, AED-CONF-64-139-21

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9	19-22515	ORINS. Gmelin, AED-CONF-64-139-25
CONF-718–		**(American Institute of Chemical Engineers Meeting, Las Vegas, Nev., Sept. 21, 1964)**
4	19-24220	ORINS. Gmelin, AED-CONF-64-163-3
CONF-720–		**(2nd Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Oct. 1964)**
12	19-23945	ORINS. Gmelin, AED-CONF-64-190-7
16	19-23341	ORINS. Gmelin, AED-CONF-64-190-17
17	19-22390	ORINS. Gmelin, AED-CONF-64-190-5
21	19-23949	ORINS. Gmelin, AED-CONF-64-190-26
24	19-21992	ORINS. Gmelin, AED-CONF-64-190-29
25	19-23944	ORINS. Gmelin, AED-CONF-64-190-28
26	19-23946	ORINS. Gmelin, AED-CONF-64-190-27
27	19-23947	ORINS. Gmelin, AED-CONF-64-190-34
28	19-22651	ORINS. Gmelin, AED-CONF-64-190-32
CONF-721–		**(8th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 6–8, 1964)**
13	19-22155	ORINS. Gmelin, AED-CONF-64-189-8
CONF-729–		**(International Conference on Beryllium, Philadelphia, Oct. 1964)**
19	19-23113	ORINS. Gmelin, AED-CONF-64-247-20
21	19-23107	ORINS. Gmelin, AED-CONF-64-247-26
22	19-22516	ORINS. Gmelin, AED-CONF-64-247-25
23	19-22951	ORINS. Gmelin, AED-CONF-64-247-19
CONF-758–		**(American Physical Society Meeting, New York, Jan. 22–25, 1965)**
3	19-23806	ORINS. Gmelin, AED-CONF-65-003-6
4	19-23805	ORINS. Gmelin, AED-CONF-65-003-5
CONF-763–		**(American Society of Mechanical Engineers Winter Meeting, New York, Nov. 29–Dec. 4, 1964)**
45	19-22453	ORINS
48	19-22499	ORINS
CONF-765–		**(2nd Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 3–6, 1964)**
10	19-22564	ORINS. Gmelin, AED-CONF-64-202-20
CONF-776–		**(National Electronics Conference, Chicago, Oct. 1964)**
4	19-23809	ORINS. Gmelin, AED-CONF-64-191-2
CONF-778–		**(Metals/Materials Congress, Philadelphia, Oct. 1964)**
5	19-24137	ORINS. Gmelin, AED-CONF-64-201-4
7	19-22018	See BNL-8165
CONF-789–		**(American Meteorological Society National Conference on Micrometeorology, Salt Lake City, Oct. 13–16, 1964)**
2	19-23160	ORINS. Gmelin, AED-CONF-64-203-1
CONF-794–		**(Magnetism Conference, Minneapolis, Nov. 1964)**
4	19-23108	ORINS. Gmelin, AED-CONF-64-204-11
6	19-22259	ORINS. Gmelin, AED-CONF-64-204-7
7	19-23158	ORINS. Gmelin, AED-CONF-64-204-3
8	19-23812	ORINS. Gmelin, AED-CONF-64-204-4
9	19-23109	ORINS. Gmelin, AED-CONF-64-204-16
CONF-799–		**(11th Annual Nuclear Science Symposium, Philadelphia, Oct. 28–30, 1964)**
16	19-24157	ORINS. Gmelin, AED-CONF-64-225-30
CONF-800–		**(6th Japan Conference on Radioisotopes, Tokyo, Nov. 16–19, 1964)**
3	19-21855	See BNL-8892
CONF-804–		**(Symposium on the Inelastic Scattering of Neutrons, Bombay, Dec. 15–19, 1964)**
29	19-23255	See PAN-569/II
CONF-611201–	19-22782 19-22783 19-22784 19-22785 19-22786	**(5th Scientific Technical Conference on Nuclear Radioelectronics, Moscow, Dec. 18–23, 1961) Proceedings**
CONF-620903–	19-21982	**(Symposium on Radiosensitivity, Quebec, Sept. 4–5, 1962) Proceedings**
CONF-630301–	19-22873	**(New Trends in the Investigation and Use of Rare Earth Metals, Moscow, Mar. 1963) Proceedings. See JPRS-28849**
CONF-630902–	19-23202	**(United German Physical Society Meeting, Hamburg, Sept. 9–13, 1963) Proceedings**
CONF-631002–		**(12th National Congress on Microbiology, Perugia, Italy, Oct. 4–7, 1963)**
1	19-21991	ORINS
CONF-631104–		**(Meeting on the Utilization of Research Reactors, Sao Paulo, Brazil, Nov. 4–8, 1963)**
4	19-22694	See IEA-76
6	19-22695	See IEA-83
CONF-631202–	19-23254	**(1st Texas Symposium on Relativistic Astrophysics, Dallas, Dec. 16–18, 1963) Proceedings**
CONF-640407–		**(3rd Annual General Meeting of IMOG, Livermore, Calif., Apr. 14–17, 1964)**
1	19-22451	See RFP-375
CONF-640606–		**(American Physical Society Summer Meeting, Denver, Colo., June 25–27, 1964)**
14	19-23930	ORINS. Gmelin, AED-CONF-64-113-3
23	19-23988	ORINS. Gmelin, AED-CONF-64-113-42
CONF-640607–	19-23992 19-23993	**(Symposium on In-core Instrumentation, Oslo, June 15–19, 1964) Proceedings**
CONF-640609–		**(Society of Nuclear Medicine, 11th Annual Meeting, Berkeley, Calif., June 17–20, 1964)**
3	19-22802	ORINS. Gmelin, AED-CONF-64-111-8
CONF-640703–	19-22253	**(Symposium on Carbon, Tokyo, July 20–23, 1964) Proceedings**
CONF-640810–		**(Conference on Nuclear Marine Propulsion, Blacksburg, Va., Aug. 10–13, 1964)**
4	19-24155	ORINS. Gmelin, AED-CONF-64-228-2
5	19-24134	ORINS. Gmelin, AED-CONF-64-228-3
6	19-24158	ORINS. Gmelin, AED-CONF-64-228-5
8	19-24159	ORINS. Gmelin, AED-CONF-64-228-6
CONF-640903–		**(American Vacuum Society Symposium, Chicago, Sept. 30–Oct. 2, 1964)**
13	19-22527	ORINS. Gmelin, AED-CONF-64-171-38
CONF-640909–		**(International Conference on Radiation Preservation of Foods, Boston, Sept. 27–30, 1964)**
5	19-22837	ORINS. Gmelin, AED-CONF-64-168-10
11	19-22838	ORINS. Gmelin, AED-CONF-64-168-17
CONF-641004–		**(American Physical Society, Chicago, Oct. 23–24, 1964)**
2	19-23619	ORINS. Gmelin, AED-CONF-64-220-6
5	19-23478	ORINS. Gmelin, AED-CONF-64-220-19
7	19-23323	ORINS. Gmelin, AED-CONF-64-220-21
8	19-23815	ORINS. Gmelin, AED-CONF-64-220-12
9	19-22258	ORINS. Gmelin, AED-CONF-64-220-24
10	19-23617	ORINS. Gmelin, AED-CONF-64-220-29
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11	19-22815	ORINS. Gmelin, AED-CONF-64-193-15
12	19-24188	ORINS. Gmelin, AED-CONF-64-193-14
13	19-22814	ORINS. Gmelin, AED-CONF-64-193-16
CONF-641016–		**(17th Annual Gaseous Electronics Conference, Atlantic City, Oct. 14–16, 1964)**
2	19-23918	ORINS. Gmelin, AED-CONF-64-223-11
3	19-23325	ORINS. Gmelin, AED-CONF-64-223-6
4	19-23919	ORINS. Gmelin, AED-CONF-64-223-7
5	19-23922	ORINS. Gmelin, AED-CONF-64-223-10
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2	19-22154	ORINS. Gmelin, AED-CONF-64-221-1
3	19-23950	ORINS. Gmelin, AED-CONF-64-221-5
5	19-23326	ORINS. Gmelin, AED-CONF-64-221-8
7	19-22152	ORINS. Gmelin, AED-CONF-64-221-11
CONF-641018–		**(The Electrochemical Society, 126th Meeting, Washington, D. C., Oct. 11–15, 1964)**
4	19-22153	ORINS. Gmelin, AED-CONF-64-205-8
CONF-641108–		**(American Physical Society, New York, Nov. 4–8, 1964)**
18	19-23917	ORINS. Gmelin, AED-CONF-64-196-55
21	19-23327	ORINS. Gmelin, AED-CONF-64-196-51
23	19-23915	ORINS. Gmelin, AED-CONF-64-196-26
24	19-23936	ORINS. Gmelin, AED-CONF-64-196-59
25	19-23914	ORINS. Gmelin, AED-CONF-64-196-60
26	19-23913	ORINS. Gmelin, AED-CONF-64-196-29
27	19-23935	ORINS. Gmelin, AED-CONF-64-196-30
29	19-23934	ORINS. Gmelin, AED-CONF-64-196-31
33	19-23921	ORINS. Gmelin, AED-CONF-64-196-39
34	19-23926	ORINS. Gmelin, AED-CONF-64-196-45
36	19-23916	ORINS. Gmelin, AED-CONF-64-196-42
37	19-23920	ORINS. Gmelin, AED-CONF-64-196-36
39	19-23923	ORINS. Gmelin, AED-CONF-64-196-58
40	19-23929	ORINS. Gmelin, AED-CONF-64-196-49
41	19-23924	ORINS. Gmelin, AED-CONF-64-196-50
42	19-23927	ORINS. Gmelin, AED-CONF-64-196-65
CONF-641112–	**19-17327 19-24221**	**(Atomic Industrial Forum, 1964 Annual Conference, San Francisco, Nov. 30–Dec. 3, 1964) Proceedings**
CONF-641114–		**(American Physical Society, Southeastern Section, Chattanooga, Tenn., Nov. 1964)**
1	19-23931	ORINS. Gmelin, AED-CONF-64-194-1
2	19-23811	ORINS. Gmelin, AED-CONF-64-194-12
4	19-23817	ORINS. Gmelin, AED-CONF-64-194-6
CONF-641115–		**(American Physical Society Symposium on Symmetry in Particle Physics, Chicago, Nov. 1964)**
1	19-23364	See NYO-3399-07
CONF-641116–		**(Conference on the Role of Grain Boundaries and Surfaces in Ceramics, Raleigh, N. C., Nov. 16–18, 1964)**
3	19-22952	ORINS. Gmelin, AED-CONF-64-224-9
5	19-23106	ORINS. Gmelin, AED-CONF-64-224-8
CONF-641201–		**(American Institute of Chemical Engineers Annual Meeting, Boston, Dec. 6–10, 1964)**
15	19-23925	ORINS. Gmelin, AED-CONF-64-235-17
16	19-22591	Dep.(mn); $2.00(cy), 2(mn) CFSTI; Gmelin, AED-CONF-64-235-19
CONF-641207–		**(American Society of Agricultural Engineers, Winter Meeting, New Orleans, La., Dec. 7–10, 1964)**
4	19-22581	ORINS
5	19-22592	Dep.(mn); $1.00(cy), 1(mn) CFSTI
CONF-641210–		**(American Physical Society Meeting, Berkeley, Calif., Dec. 1964)**
3	19-23819	ORINS. Gmelin, AED-CONF-64-236-2
5	19-22805	ORINS. Gmelin, AED-CONF-64-236-5
6	19-23476	ORINS. Gmelin, AED-CONF-64-236-6
7	19-23477	ORINS. Gmelin, AED-CONF-64-236-15
8	19-23808	ORINS. Gmelin, AED-CONF-64-236-19
9	19-23807	ORINS. Gmelin, AED-CONF-64-236-21
10	19-23816	ORINS. Gmelin, AED-CONF-64-236-22
11	19-23324	ORINS. Gmelin, AED-CONF-64-236-20
12	19-23810	ORINS. Gmelin, AED-CONF-64-236-8
13	19-23813	ORINS. Gmelin, AED-CONF-64-236-9
CONF-650105–		**(Institute of Electrical and Electronic Engineers, Winter Power Meeting, New York, Jan. 31–Feb. 5, 1965)**
4	19-24138	ORINS
5	19-23353	ORINS
7	19-23352	ORINS
8	19-24139	ORINS
CONF-650106–		**(Conference on Symmetry Principles at High Energy, Coral Gables, Fla., Jan. 1965)**
9	19-23365	See NYO-3399-17
CONF-650108–		**(AIAA 2nd Aerospace Sciences Meeting, New York, Jan. 25–27, 1965)**
1	19-23207	ORINS
2	19-23932	ORINS
4	19-23537	ORINS
5	19-23538	ORINS
6	19-22523	ORINS
8	19-23204	ORINS
9	19-23933	ORINS
10	19-22520	ORINS
11	19-23206	ORINS
12	19-22519	ORINS
13	19-23322	ORINS
14	19-22522	ORINS
15	19-22521	ORINS
16	19-22524	ORINS
18	19-23205	ORINS
CONF-650112–		**(Symposium on Dynamic Function Studies with Radioisotopes, Boston, Jan. 28–30, 1965)**
1	19-22083	ORINS. Gmelin, AED-CONF-65-004-2
CONF-650203–		**(National AIME Meeting, Chicago, Feb. 14–18, 1965)**
4	19-22836	ORINS. Gmelin, AED-CONF-65-005-1
CONF-650204–		**(Meeting on Thermocouple Technology and the Effects of Nuclear Radiation on Thermocouples, Washington, D. C., Feb. 24–26, 1965)**
4	19-22664	See ORNL-P-1070
8	19-22927	See TIM-888
CONF-650205–		**(American Institute of Chemical Engineers 55th National Meeting, Houston, Feb. 7–11, 1965)**
1	19-22500	ORINS
2	19-22501	ORINS
CONF-650209–		**(AIAA 6th Solid Propellant Rocket Conference, Washington, D. C., Feb. 1–3, 1965)**
1	19-23479	ORINS
CONF-650210–		**(Application of X-Ray Diffraction in the Atomic Energy Field Meeting, Richland, Wash., Feb. 23–24, 1965)**
3	19-22991	See ORNL-P-1165
CONF-650302–		**(IAEA Symposium on Personnel Dosimetry for Accidental High-Level Exposure to External and Internal Radiation, Vienna, Mar. 1965)**
3	19-22589	See AECL-2154
CONF-650306–		**(Particle Accelerator Conference, Mar. 10–12, 1965, Washington, D. C.)**
41	19-23210	See UCRL-11792
42	19-23940	See UCRL-11810
44	19-23211	See UCRL-11803
CONF-650311–		**(Conference on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, Mar. 5, 1965)**
1	19-22103	See TIM-904
CONF-650405–		**(International Conference on Modern Trends in Activation Analysis, College Station, Tex., Apr. 19–22, 1965)**
3	19-22097	See ORNL-P-1127
CONF-650409–		**(Pressure Vessel Symposium, ASME, Idaho Falls, Idaho, Apr. 15, 1965)**
1	19-22448	Dep.(mn); $2.00(cy), 1(mn) CFSTI
CONF-650411–		**(Joint NASA–AEC Liquid Metals Corrosion Meeting, Gatlinburg, Tenn., Apr. 21–23, 1965)**
1	19-22981	See LA-DC-7050
2	19-22982	See LA-DC-7051
3	19-22890	See BNL-9018
CONF-650414–		**(19th Metallographic Group Meeting, Oak Ridge, Tenn., Apr. 20–22, 1965)**
1	19-22969	See DPSPU-65-30-18
CONF-650419–		**(Meeting of Refractory Composites Working Group,**

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		Atlanta, Apr. 12–14, 1965)
1	19-22990	See ORNL-P-1152
CONF-650507–		**(IAEA Symposium on Radioisotope Sample Measurement Techniques in Medicine and Biology, Vienna, May 24–28, 1965)**
2	19-22701	See UCRL-12245
CONF-650508–		**(International Conference on Beryllium Metallurgy, Grenoble, France, May 20, 1965)**
2	19-22104	See UCRL-12253
CONF-650509–		**(IAEA Symposium on Nondestructive Testing in Nuclear Technology, Bucharest, May 17–21, 1965)**
3	19-22510	See SC-DC-65-1123
CONF-650511–		**(Symposium on Non-Destructive Testing in Nuclear Technology, Bucharest, May 17–21, 1965)**
1	19-22508	See ORNL-P-1188
CONF-650602–		**(American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn., June 20–24, 1965)**
19	19-24162	See BNL-8986
CONF-650604–		**(International Symposium on Working Methods in High Activity Hot Labs., Grenoble, France, June 15–18, 1965)**
1	19-22507	See ORNL-P-1109
CONF-650606–		**(EURATOM Symposium on Fuel Cycles of High-Temperature Gas-Cooled Reactors, Brussels, June 10–11, 1965)**
1	19-22406	See ORNL-TM-1096
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1	19-22084	See BDX-613-70
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7-0352	19-23722	Nucl. Phys., 68: 413-16(1965)
238-45	19-23297	Phys. Rev., 138: A688-91(1965)
498-41	19-23674	Nucl. Phys., 64: 401-19(1965)
535-538	19-23688	Nucl. Phys., 67: 542-64(1965)
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878-15	19-21856	Dep.(mn); $1.00(cy), 1(mn) CFSTI
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1198-161	19-22967	Dep.(mn); $2.00(cy), 1(mn) CFSTI
1198-232	19-23739	Phys. Rev., 138: A729-31(1965)
1420-108	19-23741	Phys. Rev., 138: B509-13(1965)
1420-109	19-23754	Phys. Rev., 138: B610-14(1965)
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85	19-22688	See CONF-640607(Vol.I)(Paper C-4)
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225	19-24074	Dep.(mn); $3.00(cy), 2(mn) CFSTI
D–	**(Misc.)**	
910082-7	19-23125	See NP-14958
DMIC-Memo–	**(Non-AEC)**	
200	19-22968	
202	19-22892	
DP–		
957	19-22893	Dep.; $1.00(cy), 1(mn) CFSTI
DPSPU–		
65-30-18	19-22969	Dep.(mn); $1.00(cy), 1(mn) CFSTI
DPST–		
65-83-2	19-24075	Dep.(mn); $1.00(cy), 1(mn) CFSTI
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1092-201	19-22971	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1092-202	19-22972	Dep.(mn); $1.00(cy), 1(mn) CFSTI
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B37	19-22975	See EURAEC-1314
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2149.e	19-23666	Nucl. Phys., 56: 394-9(1964)
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2220.f	19-22534	Dep.(mn)
2231.f	19-24067	See CEA-R-2556
2234.f	19-23822	See CEA-R-2743
2235.f	19-24066	See CEA-R-2554
2247.e	19-22690	Dep.(mn)
2256.i	19-22465	Ing. Nucl., 5: No. 2, 1-14(1964)
2273.e	19-24028	Dep.(mn)
2281.f	19-22659	Dep.(mn)
2285.e	19-24029	Dep.(mn)
2309	19-22482	See EURAEC-1332
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1148	19-22919	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1275	19-22974	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1288	19-22481	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1314	19-22975	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1317	19-22918	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1330	19-22891	See CEND-525
1332	19-22482	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1345	19-22995	See SWRI-1243-14(a)
FD–	**(Non-AEC)**	
3	19-21863	See NP-14957
6	19-22826	See NP-14984
FSU–		
2690-18	19-22159	Dep.(mn); $3.00(cy), 2(mn) CFSTI
FZK–	**(Non-AEC)**	
212	19-23121	CFSTI
GA–	**(Misc.)**	
4710	19-24078	Dep.(mn); $3.00(cy), 2(mn) CFSTI
4901	19-22976	Dep.(mn); $2.00(cy), 2(mn) CFSTI
4966	19-24076	Dep.(mn); $3.00(cy), 2(mn) CFSTI
5305	19-23595	Dep.(mn); $3.00(cy), 3(mn) CFSTI
5418	19-22691	Dep.(mn); $1.00(cy), 1(mn) CFSTI
5487	19-24079	Dep.(mn); $2.00(cy), 2(mn) CFSTI
6134	19-24077	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6163	19-22977	Dep.(mn); $2.00(cy), 1(mn) CFSTI
GAMD–	**(Misc.)**	
5503	19-22503	Dep.(mn); $1.00(cy), 1(mn) CFSTI
GEAP–	**(Misc.)**	
4183	19-22894	Dep.(mn); $4.00(cy), 2(mn) CFSTI
4759	19-24080	Dep.(mn); $5.00(cy), 4(mn) CFSTI
4798	19-22483	Dep.(mn); $1.00(cy), 1(mn) CFSTI
GEMP–	**(Misc.)**	
87	19-24016	Dep.; $1.00(cy), 1(mn) CFSTI

Report No.	Abstract No.	Availability
GNEC–		
361	19-24081	Dep.(mn); $6.00(cy), 5(mn) CFSTI
HASL–		
150	19-22692	Dep.; $3.00(cy), 2(mn) CFSTI
HUX–		
2752-1	19-23625	Dep.(mn); $1.00(cy), 1(mn) CFSTI
HW–		
65531	19-22404	Dep.(mn); $1.00(cy), 1(mn) CFSTI
70938(Del.)	19-22920	Dep.(mn); $2.00(cy), 1(mn) CFSTI
75728	19-24082	Dep.(mn); $1.00(cy), 1(mn) CFSTI
77274	19-24190	Dep.(mn); $1.00(cy), 1(mn) CFSTI
78262(Rev.)	19-22617	Health Phys., 11: 397-401(1965)
81603	19-22866	Dep.; $3.00(cy), 2(mn) CFSTI
83298	19-23995	Dep.; $5.00(cy), 4(mn) CFSTI
83601	19-22870	Dep.; $6.00(cy), 4(mn) CFSTI
83899	19-24143	Dep.(mn); $1.00(cy), 1(mn) CFSTI
84481	19-22693	Dep.(mn); $1.00(cy), 1(mn) CFSTI
84544(App.5)	19-24171	Dep.(mn); $1.00(cy), 1(mn) CFSTI
HW-SA–		
3338	19-22014	Dep.(mn); $1.00(cy), 1(mn) CFSTI; Gmelin, AED-CONF-64-082-50
3469	19-22504	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3481	19-22978	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3487	19-22535	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3510	19-22922	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3511	19-24202	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3590	19-21839	Nature, 204: 899-900(1964)
3706	19-22619	Health Phys., 11: 454(1965)
IA–	**(Non-AEC)**	
964	19-22160	Dep.(mn)
1010	19-21857	Dep.(mn)
IC–	**(Non-AEC)**	
65/13	19-23356	Dep.(mn)
65/37	19-23435	Phys. Rev. Letters, 14: 719-21(1965)
IDO–		
10042	19-22825	Dep.(mn); $2.00(cy), 1(mn) CFSTI
12039	19-24172	$3.00(cy), 2(mn) CFSTI
14654	19-24054	Dep.; $1.00(cy), 1(mn) CFSTI
17006	19-22979	Dep.; $2.00(cy), 1(mn) CFSTI
22046	19-22529	Dep.(mn); $6.00(cy), 5(mn) CFSTI
IEA–	**(Brazilian)**	
76	19-22694	Dep.(mn)
83	19-22695	Dep.(mn)
IKF-D–	**(German)**	
32	19-22696	Dep.(mn)
IPP–	**(Non-AEC)**	
3/26	19-23344	Dep.(mn)
IS–		
915	19-23054	Phys. Chem. Solids, 26: 623-9(1965)
1001	19-23680	Nucl. Phys., 64: 486-96(1965)
1003	19-22270	J. Chem. Phys., 42: 2683-6(1965)
1059	19-22840	Dep.; $4.00(cy), 2(mn) CFSTI
1080	19-22108	Anal. Chem., 37: 103R-17R(1965)
1123	19-23968	Phys. Rev. Letters, 14: 693-4(1965)
IS-T–		
4	19-24203	Dep.(mn); $2.00(cy), 1(mn) CFSTI
5	19-22161	Dep.(mn); $2.00(cy), 1(mn) CFSTI
6	19-22092	Dep.(mn); $3.00(cy), 2(mn) CFSTI
7	19-22980	Dep.(mn); $3.00(cy), 2(mn) CFSTI
8	19-22264	Dep.(mn); $3.00(cy), 2(mn) CFSTI
JINR–	**(Russian)**	
D-1926	19-23357	Dep.(mn)
E-1962	19-23480	Dep.(mn)
P-1900	19-23358	Dep.(mn)
P-1965	19-23359	Dep.(mn)
P-1982	19-23360	Dep.(mn)
P-1991	19-23361	Dep.(mn)
P-1993	19-23362	Dep.(mn)
P-1995	19-23626	Dep.(mn)
P-2000	19-22093	Dep.(mn)
P-2002	19-23954	Dep.(mn)
P-2007	19-23627	Dep.(mn)
P-2008	19-22593	Dep.(mn)
JPL-TR–	**(Non-AEC)**	
32-650(Pt.I)	19-23540	
32-685	19-24086	
JPRS–	**(Non-AEC)**	
28782	19-21796	$3.00(CFSTI)
28849	19-22873	$7.00(CFSTI)
29183	19-21797	$1.00(CFSTI)
29183(p.1-9)	19-22288	
29550	19-22931	$1.00(CFSTI)
JüL–	**(German)**	
213-ST	19-22697	Dep.(mn)
JüL-Bibl–	**(German)**	
7	19-24204	Dep.(mn)
KAPL–		
3094	19-22450	Dep.; $2.00(cy), 1(mn) CFSTI
KAPL-M–		
6195	19-22505	Dep.(mn); $3.00(cy), 2(mn) CFSTI
KFK–	**(German)**	
275	19-22661	Dep.(mn)
LA–		
3198	19-23955	Dep.; $3.00(cy), 2(mn) CFSTI
3201	19-22662	Dep.; $3.00(cy), 2(mn) CFSTI
3243	19-24205	Dep.; $2.00(cy), 1(mn) CFSTI
3248	19-22094	Dep.(mn); $1.00(cy), 1(mn) CFSTI
LA-DC–		
6505	19-22117	Anal. Chem., 37: 782-4(1965)
6635	19-23045	J. Chem. Phys., 42: 2891-2(1965)
6662	19-22216	J. Phys. Chem., 69: 1223-6(1965)
6798	19-22203	J. Chem. Phys., 42: 2822-5(1965)
6867	19-23105	See COO-1149-29
7050	19-22981	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7051	19-22982	Dep.(mn); $1.00(cy), 1(mn) CFSTI
7061	19-23763	Phys. Rev. Letters, 14: 739-41(1965)
LADC–		
6436	19-22663	Dep.(mn); $1.00(cy), 1(mn) CFSTI
6449	19-24206	Dep.(mn); $1.00(cy), 1(mn) CFSTI
MATT–		
258	19-23823	Dep.(mn); $1.00(cy), 1(mn) CFSTI
MIT–	**(Misc.)**	
905-10	19-22095	Dep.(mn); $1.00(cy), 1(mn) CFSTI
905-29	19-22268	J. Am. Chem. Soc., 87: 1553-61(1965)
2098-69	19-23696	Nucl. Phys., 68: 49-85(1965)
2098-118	19-23753	Phys. Rev., 138: B597-607(1965)
MSAR–	**(Misc.)**	
65-47	19-22896	Dep.(mn); $1.00(cy), 1(mn) CFSTI
N–	**(Misc.)**	
64-19477	19-22518	See NASA-TN-D-2172
NAA-SR-Memo–		
10529	19-24087	Dep.(mn); $2.00(cy), 1(mn) CFSTI
10704	19-24146	Dep.(mn); $1.00(cy), 1(mn) CFSTI
10730	19-24147	Dep.(mn); $1.00(cy), 1(mn) CFSTI
10885	19-22983	Dep.(mn); $2.00(cy), 1(mn) CFSTI
NASA-CR–	**(Misc.)**	
210	19-24148	$3.00(CFSTI)
212	19-24149	$1.00(CFSTI)
54167	19-22984	
NASA-SP–	**(Misc.)**	

Report No.	Abstract No.	Availability
7011(08)	19-21787	$1.00(CFSTI)
NASA-TN–	**(Misc.)**	
D-2172	19-22518	$2.75(CFSTI)
NC–	**(Norwegian)**	
63	19-23998	See TID-21733
NDL-TR–	**(Non-AEC)**	
56	19-24173	
NMI–	**(Misc.)**	
2135	19-22924	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2137	19-22925	See NYO-2784-8
7004	19-22923	Dep.(mn); $1.00(cy), 1(mn) CFSTI
NP–	**(AEC File No. for Non-AEC Reports)**	
14779	19-21788	
14832	19-24174	Dep.(mn)
14882	19-23939	
14890	19-23824	$3.60(CFSTI)
14891	19-23345	
14917	19-23825	
14919	19-23346	
14937	19-21789	Dep.(mn)
14951	19-22985	
14954	19-23363	
14957	19-21863	
14958	19-23125	
14968	19-22506	Dep.(mn)
14976	19-22594	
14982	19-21790	$5.00(CFSTI)
14984	19-22826	
NRL–	**(Misc.)**	
6186	19-23628	
6229	19-22536	$1.00(CFSTI)
6231	19-22986	CFSTI
NUMEC–		
3428-6	19-22987	Dep.(mn); $1.00(cy), 1(mn) CFSTI
NYO–		
1669-10	19-22567	Dep.(mn); $6.00(cy), 4(mn) CFSTI
1930-40	19-22282	Dep.(mn); $3.00(cy), 1(mn) CFSTI
2765-1	19-22484	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2784-6	19-22924	See NMI-2135
2784-8	19-22925	Dep.(mn); $2.00(cy), 1(mn) CFSTI
2811-23	19-22988	Dep.(mn); $3.00(cy), 2(mn) CFSTI
2910-9	19-24175	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3399-04	19-23408	Phys. Rev., 138: B665-6(1965)
3399-05	19-23412	Phys. Rev., 138: B689-91(1965)
3399-07	19-23364	Dep.(mn); $1.00(cy), 1(mn) CFSTI Current Sci. (India), 34: 202-7(1965)
3399-17	19-23365	Dep.(mn); $1.00(cy), 1(mn) CFSTI
3429-2	19-23347	Dep.; $2.00(cy), 1(mn) CFSTI
ORNL–		
3575	19-23162	Dep.(mn); $2.00(cy), 1(mn) CFSTI
3650	19-21791	Dep.; $6.00(cy), 4(mn) CFSTI
3669	19-22839	Dep.; $2.00(cy), 1(mn) CFSTI
3738	19-23629	Dep.; $3.00(cy), 2(mn) CFSTI
3755	19-22457	Dep.; $3.00(cy), 1(mn) CFSTI
3766	19-22859	Dep.; $3.00(cy), 2(mn) CFSTI
3776	19-22595	Dep.; $5.00(cy), 3(mn) CFSTI
3780	19-24176	Dep.; $2.00(cy), 1(mn) CFSTI
3781	19-24177	Dep.; $1.00(cy), 1(mn) CFSTI
ORNL-P–	**(Misc.)**	
54	19-22514	Mater. Evaluation, 23: 191-5(1965)
78	19-23670	Nucl. Phys., 61: 342-51(1965)
439	19-21831	Health Phys., 11: 403-51(1965)
733	19-22111	Anal. Chem., 37: 680-7(1965)
789	19-23694	Nucl. Phys., 68: 17-35(1965)
792	19-22340	J. Phys. Chem., 69: 1413-19(1965)
800	19-22743	Nucleonics, 23: No. 3, 67-9(1965)
840	19-23058	Phys. Rev., 138: A755-9(1965)
842	19-22198	J. Am. Chem. Soc., 87: 1710-14(1965)
846	19-23057	Phys. Rev., 138: A737-43(1965)
913	19-22208	J. Chem. Phys., 42: 2982-3(1965)
916	19-23697	Nucl. Phys., 68: 97-140(1965)
937	19-23743	Phys. Rev., 138: B520-5(1965)
952	19-22112	Anal. Chem., 37: 687-9(1965)
989	19-22114	Anal. Chem., 37: 742-8(1965)
1070	19-22664	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1102	19-23736	Phys. Letters, 15: 337-9(1965)
1104	19-22269	J. Am. Chem. Soc., 87: 1802-4(1965)
1109	19-22507	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1127	19-22097	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1152	19-22990	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1165	19-22991	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1188	19-22508	Dep.(mn); $2.00(cy), 1(mn) CFSTI
ORNL-RMIC–	**(Oak Ridge National Lab.)**	
3(Rev.)	19-22871	Free(ORNL)
ORNL-TM–		
855	19-24017	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1047	19-22841	Dep.(mn); $4.00(cy), 3(mn) CFSTI
1054	19-22164	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1058	19-22099	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1059	19-22100	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1068	19-22601	Dep.(mn); $3.00(cy), 2(mn) CFSTI
1096	19-22406	Dep.(mn); $2.00(cy), 1(mn) CFSTI
ORNL-tr–		
537	19-24097	Dep.(mn); $8.10(fs), $2.75(mf) JCL
538	19-24098	Dep.(mn); $3.60(fs), $1.22(mf) JCL
PAEC(A)IN–	**(Philippines)**	
643	19-24207	Dep.(mn)
PAN–	**(Polish)**	
546/XIV	19-23126	Dep.
554/II	19-22992	Dep.
569/II	19-23255	Dep.
PATENTS	**(Australian)**	
216,976	19-22439	
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
975,330	19-22261	
980,741	19-24059	
980,742	19-24060	
980,759	19-22887	
980,895	19-22469	
980,943	19-24044	
980,947	19-23621	
980,978	19-24022	
980,992	19-22440	
981,044	19-22441	
981,065	19-22954	
981,149	19-22683	
981,189	19-22470	
981,297	19-23622	
981,423	19-24047	
981,424	19-24048	
981,425	19-24049	
981,426	19-24050	
981,565	19-24023	
981,668	19-24189	
981,888	19-22806	
981,894	19-22471	
981,927	19-24024	
981,940	19-24025	
PATENTS	**(German)**	
1,176,631	19-22442	
1,178,151	19-24061	
1,178,155	19-23233	
1,178,188	19-24026	
1,178,220	19-23116	
1,178,409	19-22262	
1,178,836	19-22263	
1,178,951	19-22807	
1,179,719	19-22913	
1,181,187	19-22955	
1,181,332	19-24051	
1,181,333	19-24027	
1,181,342	19-23234	

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1,182,358	19-22652	
1,182,362	19-24062	
1,184,026	19-23952	
1,184,429	19-23937	
1,185,302	19-22808	
1,186,639	19-22956	
1,186,903	19-22809	
1,186,957	19-24045	
PATENTS	**(U. S.)**	**$0.25 each, U. S. Patent Office**
3,154,479	19-22392	
3,154,480	19-22393	
3,154,499	19-22403	
3,173,757	19-22443	
3,173,973	19-22957	
3,174,834	19-24222	
3,174,921	19-22394	
3,175,104	19-24223	
3,175,922	19-22958	
3,175,931	19-24224	
3,176,195	19-23594	
3,177,408	19-23938	
3,178,256	19-22444	
3,178,258	19-22445	
3,178,259	19-22959	
3,178,356	19-24052	
3,179,501	19-22446	
3,179,503	19-22447	
3,179,722	19-22960	
3,180,756	19-24225	
3,180,801	19-24053	
PNE–		
107F	19-22454	Dep.; $3.00(cy), 2(mn) CFSTI
449	19-24208	Dep.(mn); $1.00(cy), 1(mn) CFSTI
451	19-24209	Dep.(mn); $2.00(cy), 1(mn) CFSTI
452	19-24210	Dep.(mn); $1.00(cy), 1(mn) CFSTI
474	19-24211	Dep.(mn); $1.00(cy), 1(mn) CFSTI
477	19-24212	Dep.(mn); $1.00(cy), 1(mn) CFSTI
PUC–		
1964-147	19-23635	Ann. Phys. (N. Y.), 31: 525-47(1965)
PWAC–	**(Misc.)**	
123	19-22509	Dep.(mn); $1.00(cy), 1(mn) CFSTI
R–	**(Misc.)**	
64MCD500	19-23127	
64SD90	19-23826	
RFP–		
375	19-22451	Dep.(mn); $1.00(cy), 1(mn) CFSTI
442	19-22407	Dep.; $1.00(cy), 1(mn) CFSTI
456	19-22101	Dep.(mn); $1.00(cy), 1(mn) CFSTI
RISO–	**(Danish)**	
94	19-22602	Dep.(mn)
96	19-22993	Dep.(mn)
RPI–	**(Misc.)**	
328-20	19-23209	Dep.(mn); $3.00(cy), 2(mn) CFSTI
RRL–		
146	19-23273	J. Chem. Phys., 42: 2639-43(1965)
RT-MET–	**(Italian)**	
(64)-3	19-22994	Dep.(mn)
SC-DC–		
65-1123	19-22510	Dep.(mn); $1.00(cy), 1(mn) CFSTI
SC-R–		
64-1357	19-22455	J. Waterways Harbors Div., Am. Soc. Civil Engrs., 90: No. WW4, 27-54(1964)
SC-RR–		
64-967	19-23235	Dep.(mn); $1.00(cy), 1(mn) CFSTI
65-47	19-21793	Dep.; $2.00(cy), 1(mn) CFSTI
SCL-TM–		
64-110	19-24213	Dep.(mn); $2.00(cy), 1(mn) CFSTI
SLAC-PUB–		
58	19-23415	Phys. Rev., 138: B707-11(1965)
SM–	**(Misc.)**	
56-29	19-22589	See AECL-2154
SRO–		
112	19-24088	Dep.(mn); $1.00(cy), 1(mn) CFSTI
114	19-24089	Dep.(mn); $1.00(cy), 1(mn) CFSTI
SSD-TDR–	**(Non-AEC)**	
64-267	19-23827	
STL/TN–	**(Non-AEC)**	
60-0000-09099	19-22528	See AD-607367
SU-SEL–		
64-103	19-23164	Dep.(mn); $6.00(cy), 4(mn) CFSTI
SWRI–		
1228-56	19-24090	Dep.(mn); $1.00(cy), 1(mn) CFSTI
1243-14(a)	19-22995	Dep.(mn); $3.00(cy), 2(mn) CFSTI
TDR–	**(Non-AEC)**	
469(5220-10)-3	19-23827	See SSD-TDR-64-267
TID–		
3728	19-24214	Free(DTI Extension)
18968	19-22603	Dep.(mn); $1.00(cy), 1(mn) CFSTI
20277	19-22190	Inorg. Chem., 3: 1242-5(1964)
20409	19-22135	J. Polarog. Soc., 10: 7-16(1964)
20697	19-22452	Dep.(mn); $1.00(cy), 1(mn) CFSTI
20775	19-23683	Nucl. Phys., 64: 524-8(1965)
20909	19-22669	Health Phys., 11: 320(1965)
21259	19-23055	Phys. Chem. Solids, 26: 691-6(1965)
21363	19-23708	Nucl. Phys., 68: 241-69(1965)
21367	19-23686	Nucl. Phys., 67: 517-28(1965)
21464	19-21873	Am. J. Ophthalmol., 59: 216-21(1965)
21486	19-22285	Dep.(mn); $1.00(cy), 1(mn) CFSTI
21499	19-23828	Dep.(mn); $1.00(cy), 1(mn) CFSTI
21500	19-24091	Dep.(mn); $3.00(cy), 1(mn) CFSTI
21501	19-24092	Dep.(mn); $4.00(cy), 2(mn) CFSTI
21527	19-23756	Phys. Rev., 138: B627-36(1965)
21547	19-22698	Dep.(mn); $1.00(cy), 1(mn) CFSTI
21548	19-23829	Dep.(mn); $1.00(cy), 1(mn) CFSTI
21552	19-22537	Dep.(mn); $2.00(cy), 1(mn) CFSTI
21558	19-22113	Anal. Chem., 37: 718-21(1965)
21600	19-22827	Dep.; $3.00(cy), 2(mn) CFSTI
21657	19-22319	J. Am. Chem. Soc., 87: 1686-91(1965)
21679	19-21864	Dep.(mn); $1.00(cy), 1(mn) CFSTI
21716	19-22286	Dep.(mn); $1.00(cy), 1(mn) CFSTI
21726	19-24178	Dep.(mn); $1.00(cy), 1(mn) CFSTI
21733	19-23998	Dep.(mn); $4.00(cy), 3(mn) CFSTI
21741	19-23605	J. Nucl. Energy, Pt. A & B, 19: 265-7 (1965)
21777	19-22996	Dep.(mn); $2.00(cy), 1(mn) CFSTI
21786	19-24191	Dep.(mn); $3.00(cy), 2(mn) CFSTI
TIM–	**(Misc.)**	
655	19-22897	Dep.(mn); $1.00(cy), 1(mn) CFSTI
888	19-22927	Dep.(mn); $1.00(cy), 1(mn) CFSTI
900	19-22102	Dep.(mn); $1.00(cy), 1(mn) CFSTI
904	19-22103	Dep.(mn); $2.00(cy), 1(mn) CFSTI
TRG-Report–	**(British)**	
603	19-22744	Nucleonics, 23: No. 3, 71-4; 96(1965)
842	19-22997	Dep.; $0.50(BIS); 2s. 6d. (HMSO)
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